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Hydraulic System.

It is the Nervous System that particularly distinguishes Man & fitts him for life & action. The Hydraulic is however neceſsary to his Existence, a most important part therefore, but not so much so as hath been formerly imagined.

This part seems to promise much and to be able to be reduced to some certainty; whether this has been done is to be considered. We shall divide our plan into four parts.

I. Veſsels which contain the Blood.
II. Course of these Veſsels.
III. Power by which the Blood is moved.
IV. General Laws & affections of the System so far as it is Hydraulic.

I. Veſsels that contain the Blood, which are the Heart, Arteries, and Veins. Secretories shall be spoken of in another place.

1. The Heart is a hollow Muscle with two cavities called Ventricles & two appendages called Auricles; it is attached to the Arteries & Veins, & each Ventricle communicates with an Artery

and one Vein only, at whose mouths are valves which only suffer fluids to paſs one way. These Cavities are each surrounded with a fleshy Maſs separable into distinct fibres wch lie in very different directions. This arrangement has been particularly studied, but as yet without much succeſs. We can plainly see that they are Muscular fibres, & in consequence of this these cavities are alternately dilated & contracted, & so far capable of contracting as not to have a drop of fluid in them which is effected from the great inequality of their inner surfaces, hollows, & prominencies, otherwise it would have been impoſsible.

2. Arteries wch are distinguishable enough from the Vein. The two great & principal ones are the Aorta & Pulmonary, all the other are from these. We shall speak,

1. Of their Solid Matter.
2. Their variety in this respect.
3. Their form & figure.
4. Course, Flexures, & Angles.
5. Communications.
6. Various Terminations.

First, Of their Solid matter. They are composed of a number of concentric coats. The most internal is of Cellular texture which can hardly be distinguished from the surrounding Cellular texture, but is densest nearest the Artery & so very dense when quite in contact that it hath got the name of a distinct coat that has been called Nervous; this is particular in Brutes, and more in Males than females & this shews that the firmneſs of the Arteries greatly depends on this Coat. — Next comes what is called the Muscular Coat. — Whether it is such is a question. Nicholls and Hunter have declared in the Negative. It is certain that it has an Arrangement, but by it's great density is very different from any other Muscular fibre, it is more like a Tendon or Ligament.

To this has been joined that the Arteries shew no Irritability. Haller adopts this — Verchéur declares they do; but of this by & by. Next under this is a layer of Cellular texture — then the internal Coat — such in general is the Solid parts of Arteries.

Second. Variety of the different Veſsels with regard to their solid matter. The strength of the Arteries is very considerable both in resisting Dilation & Rupture. The Aorta of a young

Man was broke by 132 ℔ appended from it.

By a Set of accurate Experts, made by Dr Wintringham junr the force or strength of the Arteries appeared deficient in different parts; it is greater the further you recede from the Heart; how far this extends is difficult to say. We may however say that the strength increases as we recede from the Heart. At the time the density increases it appears that the thickneſs of the Coat is leſs & leſs with respect to the hollow or Cavity. These Experts of his are as yet but imperfect.

Third. From Figure & Proportion. A transverse Section wherever cut is circular; this is proved by Dr Pitcairn. Haller hints that this demonstration proceeds from a supposed general flexibility. We may suppose that neighbouring preſsure may alter this form. It is in every part nearly Cilindrical, some have said that they were also Conical, but this is very doubtful, and I am sure not so much as has been generally imagined, indeed it is denied at present. If you take one Ramification you may call it a Cone whose base is in the Heart; all the branches are however larger than the trunk — thus we have a Cone in a different direction & whose Apex is in the

Heart, yet there are Examples of Arteries being enlarged between two Ramifications, but this is far from being universal, for in general the branches are generally larger. The proportion that has been assigned is not well founded, & indeed no general & constant proportion obtains _ Of this hereafter.

Fourth. Course, Flexures, & Angles. They are generally situated deeper than the Veins very rarely in a strait line especially where they send off Ramifications or where they belong to parts liable to different degrees of Extension. Of the last there is a convincing proof in the Arteries of the Stomach & Uterus & there are every where Ramifications which always produce Flexures.

Upon this subject of Ramification much notice hath been taken of the Angles at which branches go off. It is always almost Acute, never Abtruse that I know. _ Haller thinks the most common Angle is one of 45 degrees & that the largest branches pass off at the least Angles. _ Physiologists have not properly distinguished between Angles or Ramification and Devarications; thus when the Aorta divides into the Iliacs I call a Devarication, where the Emulgent go off there is an Angle.

Fifth. Communication or Anastomosis; this last term is well enough understood. We may remark that they are more frequent as we go from the heart so as at length to form net works as Plexuses. There are however several other varities in the Extremities of Arteries. Some end like the hairs of a Brush, others like the branches of a tree, some like convoluted tubes. With regard to the Anastomoses I shall propose a serious question, whether when Arteries pass over to different sides as in the head, do they inosculate or not? —— Erysipelas will sometimes only occupy one side & the Anatomist can inject on half of the tongue. But yet Inflammation gradually creeps over from one side to the other. Now if we admit of Inosculation we can account for the spreading of Inflammation, if not we must seek for some other.

The Arteries are distributed to every Minute part of the body. All inorganic parts are parts composed of Cellular Texture condensed, and have no Arteries, all others have.

Sixth. Various terminations of Arteries. Terminations of Blood arteries are of three kinds.

1. Into Veins which are no more than Arteries

reflected after which there are frequent Anastomoses.

2. Where the Arteries open into Cavities, into some of which they pourred blood, which is again taken up by the Absorbent Veins, such are in the Penis Clitoris & Mammæ.

3. Where the extreme Arteries go off in serous or lymphatic arteries. This Arteries terminate in this manner

α. Into Serous Veins; these have never been shewn to the Eye sight, but since we can inject the part which we suppose pass off from these by the veins.

β. Secretories, terminate thus,

αα. In Cavities

ββ. To throw out Excrementitious matter.

γγ. Exhalents. It is a question here whether the fluid comes out here in this state or in vapour, we incline to the last. With regard to this a curious question hath arisen about the numerous subdivision of Vessels wch must depend altogether on the subdivision of the blood. But this is denied by Haller, & to whom I must referr you. His Arguments are

1. That we can paſs Injections into the secretories.

2. In various deseases the red globuelar get into them.

3. Veins. They have this solid substance as well as the Arteries, & are composed of cellular texture & an internal membrane, but they are so thin that it is hard to speak of them with precision. It is doubtful whether they have muscular fibres, it is plain they have something like them near the heart, & perhaps at a greater distance they only escape our notice. These thinner Coats of the Veins are stronger than their corrispondent Arteries especially in the beginning of life or in Youth, yet this proportional strength varies untill at length it comes over to the side of the Arteries. Upon the whole I should refuse that the Veins have a Muscular Coat thro' the whole System or such a coat as I think we shall demonſtrate to the Arteries. The Veins tho' thinner & denser are of a greater force of Cohesion than their corrispondent Arteries. The Veins as we recede from the heart have an increase of thickneſs

in their Coats in proportion to their Cavities. These particular proportions hold absolutely during the whole of Life, but then it differs much proportionably. The Arteries being always exposed to a greater preſsure than the Veins must always be gaining upon them in proportion of their density, but since all the Experiments of this kind are few & only made by one person we cannot trust too much to them. But in the Animal Œconomy we must not attend so much continually to the absolute force of Cohesion as to their Flexibility, and we still want Experments on this head.

In my last year's course I made some Observations on Aneurisms & Varices; this at present I shall omit.

All I said of circular sections, Trunks, branches &c of Arteries agree with the Veins. The size & number of Veins is greater than that of Arteries, the flexures leſs, & this Anastomoses more frequent. The Veins have Valves that the Arteries have not; of this by & bye.

As to their Terminations, or, more properly, source, they are of 3 kinds ———

1st

1. From red Arteries.

2. From Colourleſs Arteries.

3. From Absorbent veſsels, where ever the Arteries pour out red blood. Whether there are any veins that are to be called Colourleſs Absorbents is doubtful. The Arguments that were formerly thought conclusive on this head are by no means at present thought to be such, besides it is not demonstrated that the Absorbents terminate in valvular Lymphatics, ~~yet~~ something may be said for the venal absorbents, & it is a point I would not give up— tho' I must confeſs it is but doubtful. Besides no Lymphatic have as yet been found in the Brain & yet there is a quantity of fluids poured out there, and in Ecchymosis we find that the red blood is taken up; indeed here we suppose there to have been a rupture, & even yet it might be said to be taken up by the Lymphatics themselves.

I do not think it neceſsary here to take notice of any particularitys that may occur in different parts of the venal System; as for the valvular Lymphatics themselves I must imagine you are all acquainted with & therefore shall leave them, at least for the present.

II. Course that the Blood observes, for this I shall enterely referr you to the Anatomist, as it is a thing I cannot conceive any of you to be deficient in.

The proofs were all known & declared by Harvy except the single circumstance of joining Veins & Arteries wch is now sufficiently understood & demonstrated.

We know by the alternate rising & subsiding of the Brain that it is occasioned by the difficulty of the paſsage of the Blood in the end of Expiration; this occasions a kind of Fluctuation over the whole System. Besides upon Examining with the Microscope we often see a kind of retrograde motion which continues in some small Arteries for a little time, but neither this nor the last are any exceptions to the general rule of Circulation.

I should here observe that the Circulation is very different in the fœtus to what I have been relating.

We must consider the Blood in the Heart as alternately stagnating and flowing. — The motion of the two Auricles & of the two Ventricles are respectively & exactly syncronous; as to the time in which their motions are performed there are various conjectures. The Systole is quicker than the Diastole, but that the former takes no more than one half of the time of the latter is by no means established, neither is it possible to ascertain it.

III. Power by which the Blood is moved.

I. The Heart. This is almost by every body thought to be the principal power applied or employed. It is truely a Muscular power, & analagous to that exercise in every part of the System. What is it, that excites this Contraction? It must be either a vis Nervea or a Stimulus applied directly to the Muscle itself.

1st Then with regard to the Stimulus. This must either be distension or Acids, & this last must either be mechanical or chemical. As to the Mechanical no body admits it & as to the Chemical it is by no means demonstrated, & tho' we might suppose Acids yet this constant application would at length render them of none effect. It must therefore be to Distension or the Influx of venous blood that we are to have recourse to, & it alone; Muscles may be acted on by a Vis Nervea, & this is under the power of the Common Energy of the Sensorium. The question is whether in every Contraction a vis nervea is employed, but independant of the stimulus the Vis Nervea is concerned. This I take from the effect of the Paſsions alone, & from this consideration I would call the Heart a voluntary Organ. But whatever be the cause let us now enquire into the force, wch has been frequently attempted by good Mathematicians & Physiologists; but as to the solutions of the former in Physiology where it is so difficult to ascertain the data upon which they proceed that I am inclined to reject them & the calculation drawn from them as uncertain; besides no two of them ever agree, nay so far from this that they differ upon this very principle on which they build, Borelle has far overshot the mark making the force of the Heart 180,000 ℔, & Kiel seems much under it.

Dr Hales computed by observing how high the blood would ascend in Glaſs tubes & computed that the force of the Blood circulating is as 60 88, but I must own I dare not use this, for it may be said that the force is greater as it not only raises the blood in the Tube, but also in every other part of the System; this should make it appear greater. On the other hand since a sense of resistance proves a Stimulus it may be said that in the present case the heart exerts much above it's natural force; besides it's sustaining the column is the effect of a repeated number of Pulsations & not of a single one, hence Sauvages says that instead of six feet it should be perhaps only 16 inches, so much are we wraped up in obscurity & want of foundation.

II. The next question is with what velocity the Blood moves. If we knew exactly the quantity thrown out at one Systole & the Area of the first Vessel we should be able to clear this up, but as yet a single point is not determined. Hales thinks that the Blood moves 50 feet in a Minute, Sauvages not half so much. We see then that these two famous questions are nearly as far from being determined as they were 100 years ago. — Undoubtedly the Blood moves more

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more & more slowly the farther it goes. Let us now endeavour to discover the causes of this retardation.

1. In an Animal in health the Arterial System is constantly full, consequently in every Systole it should seem that so much of the Heart's force is lost as is required to dilate the Arteries; but then upon contracting the Arteries return upon the blood the full force that was expanded upon them by the Heart. The loſs here must be very small; but besides this the Arterial System must lift the whole of the compreſsing Atmosphere at every pulsation, but here again the same force is returned as given.

2. The other resistance is that of about 50 lb of blood that is to be moved; this can but with difficulty be applied to any purpose, for it is nearly equally balanced & does not give any general retardation.

It is said that the capacitys of the Arteries are constantly encreasing, hence the force of the blood must be continually decreasing, but what is exactly the effect of this is hard to say, tho' I do not suppose the increase to be much &

therefore the force lost in the blood from this must be trifling. I do indeed allow that some small enlargements take place but we know nothing in what proportion, and as to any general & exact rule I believe does not happen, & this is also allowed by Senac & Haller. Nay I even think that there is in some places rather a diminution than an Enlargement. Observations shew that the motion of the Blood in the small vessels is greater than it could be on any supposition of this kind

4. Another resistance is from Flexures & angles, this is as difficult to be estimated as any of the other. All these flexures are Elastic & therefore must return the force lost upon them, it is their friction alone that is to be regarded here; If any forcing matter makes a flexure it is a real resistance, but even here we can suppose that at sometimes there may be a situation equally favourable for the passage of the blood. At the flexures where the Arteries become veins I suppose there is always a resistance.

5. Another cause is the Angles at which the

blood paſses off. This is a very different question & there are disputes about the very principles we are to reason on. This however I think is but inconsiderable, & neither from Injections nor what we find in the human body can we suppose it to have any great effect. I very much doubt whether in any place there is a veſsel that goes off at a right angle but always at an accute one. In general these going off of veſsels are more properly devarications than Angles. Where Angles become frequent they are almost all of them Ramifications. There then admit of no Calculation for all is precarious. I had almost forgot to take notice of that celebrated Problem of the alternate Contraction & relaxation of the heart. It is now easy in comparison of what it has been; many solutions of it have been offered but none of them are satisfactory & you yourselves will see that they are without foundation.

It is by considering the Heart as a Muscle that is capable of being stimulated by Distension. The Venous blood is what produces this Distension, but besides this the heart is in various instances under the influence of the Vis Nervea; it may seem odd that it is not liable to Spasms, of wch I have heard no instances; it may also seem odd that it's contractions are not more permanent.

There is something in the nature of Muscles wch I attempted to explain before that it inclines it's motion to be alternate, thus if we cut a heart out & stick a Needle into it & still let it remain we shall find that the Actions will be alternate, and even this law of Muscular fibres should be had recourse to in accounting for the alternate contraction of the heart by the Nervous blood.

I now return to the Resistance of the paſsage of the Arterial blood. I have already spoken of most of them.

6. Anastomoses are another circumstance. This is something but it is difficult to say what & how great it is, & perhaps they are of greater aſsistance than Detriment, at least upon the whole it appears so to me; hence with regard to the force of the heart it would be nearly balanced.

7. Friction is the last resistance & this we know takes place in every communication of motion, this I think has been very inaccurately considered. Friction is of two kinds

1. Inequality of surfaces. This is taken off by polishing the surfaces or by frictions wheels, but this friction cannot take place between solids & fluids, for a fluid is composed entirely on friction wheels. There is a resistance that arises from adhesion of surfaces which hath been confounded with this, and this is increased by that kind of polishing wch destroys the former. This may take place in the Arterial System, but how great it is is not in our power to say. It is different from difference of matter and prevails particularly in matter of the same kind. I do not think we have any reason to suppose that in any circumstance there is a repulsion, there may indeed be more or less adhesion, but I know of no instance where there is a repulsion.

Now in the Arterial System it is the application of a fluid to a wet solid and not to a dry one. There may be some resistance from the supposed viscidity of the Animal fluids, but this we apply improperly to the living Animal for the heat keeps it fluid. It is very difficult to say why the red globules of blood have so little cohesion with each other. We supposed the different parts of the blood to be in a diffused state & that it's particles have very little attraction to each other, this & the several powers applied keep it fluid. Now in the great veſsels we suppose that all the parts circulate intimately mixed together, and I do not believe that there is any veſsel in which the red globules paſs off alone or without having some other fluid along with them that is in the blood.

Thus I have endeavoured to leſsen the resistance from friction & viscidity but yet I would not pretend to say that they are taken off altogether, all that I say is that it cannot be computed, and little conclusion can be drawn from Dr Hales's Experiments, & still leſs from Sauvages in the Berlin Memoirs. In Hales's Exper^{ts} the resistance seems chiefly to have arisen from the Constriction of the veſsels, especially those that he made by Astringent liquids.

All that I have endeavoured to prove is that the resistances have always been computed too high. Most other supposed resistances seem to be of little or no weight, we shall have recourse to the muscular coat of the Arteries to overcome these if we can prove the existence of such a Coat.

There is then no power we can have recourse to but the Action of the Arteries themselves; this then is a point of the greatest importance. The doubts that have arisen proceed from our not being sensible that the Arteries have muscular fibres. The muscular Coat has been doubted by several very great Anatomists from it's appearance, by Nicholls, Hunter, &c, and Hales, because they are not irritable as he says, but this is contradicted & found to be Muscular Verpheur: Dises Inaug:. All the Arteries we can examine have a sort of fibres that seem to be Muscular but different from any others of different parts, are very tender & more like tendons or Ligaments than Fleshy. Something in the Experts of Hales seemed like irritability from chemical Stimuli, but these of no consequence for or against the doctrine or opinion. Hales [illegible] seems to have examined chiefly in dead bodies in a contracted state when it was impoſsible they could shew any irritability. Besides, the Experimts of Verchauir put this affair beyond a doubt.

From what has been said before, this question of the Muscular fibres of the Arteries may be managed in different ways.

First, we may suppose that the Arteries have muscular fibres tho' in a leſs degree than in most other parts. This I think cannot be denied if we consider that many Muscular fibres become Tendinous & therefore there may be intermediate degrees of Contraction. As for Dr Haller's Experiments we may say that they were made upon dead Animals consequently in a contracted state, besides those Experiments are remarkably nice. The insufficiency of the heart for the Circulation in all cases & it's absolute incapacity in many prove this, and the diseases of Arteries prove it beyond a doubt. But yet all this proceeds on calculation. I shall read to you the accurate Dr Verchuir who has demonstrated this before the most learned Profeſsors at Ganinge metropolis of Frisia, he yesterday was present at Lecture which prevented one from commenting upon them. There is so great an appearance of Candour runs thro' the whole of this Author that I cannot doubt of the justneſs & veracity of his Experiments. I think we have many confirmations of this doctrine in the morbid Phænomena of the body, as topical Inflammation, Palsy, Gangrene &c which prove that the blood is distributed unequally while the action of the Heart continues the same.

This might be said depends upon unequal resistence, but I think they depend also on the irritability of the Arteries, and after all I conclude that the Arteries are an irritable part of the System tho' perhaps leſs so than most other muscular fibres, it pretty generally follows the natural stimulus, which may here be the force of the propelling power of the heart, and this commonly makes it correspond with it, but we see it can differ, altho' it generally acts from one Stimulus, yet particular Stimuli can produce difference in different parts. The motion of the Blood then depends upon the conjoined action of the Heart and Arteries. As to the Oscillations of

Dr Whytt I neither understand it nor can I apply it. I conceive that the irritability of Arterias may be extended to a great length & so very smal Arteries. The action of the heart may only proceed to certain length, after this says Whytt the action of the Arteries alone perform the office entirely of propelling the Blood. He supposed that it is like the Peristaltic motion of Alimentary Canal & that the Contraction of an Upper part necessarily excites the next adjoining; thus, take an Artery of an inch long the Contraction first takes place in a tenth of it's length & propells the blood into the next tenth which is now excited to Contraction, & thus on to Extremity, & he imagines that the force of the Heart fills the beginning or first tenth part of this Artery, & now this Artery acts itself; This is his meaning if I understand him right. Thus then Dilatation gradually proceeds & acts as a Stimulus, according to Whytt; it may be possible, nay I think such appearances do sometimes take place even in the larger Arteries but not in the manner Dr Whytt supposes for Verscheur found that upon stimulating an Artery the Contraction proceeded for a great length even into Branches of the Artery, but in the smaller veſsels it is more doubtfull, because no Experiments shew that it does take place, tho' this indeed is but an Argument of very little weight because of the Extreme minuteneſs of the parts, & Haller's Microscopical Observations made on Frogs &c; where he says that extreme Arteries are not delated by the blood & that they are merely transparent firm canals or tubes but these make equally against simple Elasticity & yet he himself says that these Vessels are fuller & more turgid after feeding.

Dr. Whytt has endeavoured to establish this doctrine by Calculations on the force of the heart not being able to push the blood thro' the whole of the Arterial System, but I have before given my reason why these Calculations cannot be just, & I reject the Hypotheses entirely for the Action of the Heart. We know that we can push the Blood thro' the whole of the Arterial System into the Vein, and we find that no more force is required in Injections to push them into the Secretions, and we don't admit numerous series of decreasing Veſsels as some have done.

Several Glands are but little affected by the Motion of the Heart, but on the other hand we find that several of the Secretions are increased by the increased Action of the Heart & Arteries. Perspiration which is one of the finest Excretories is in a good measure dependant upon the action of the heart & Arteries, & Secretions are generally in proportion to the Excretions, hence by Stimulating the Excretory Veſsels we promote Secretion, & where this does not take place there may be several causes besides the bare exility of the vessels.

In Plants there is a motion of fluids in small Canals tho' there is no heart to propell them, now the quantity absorbed is influenced by the quantity exhaled, & something like this may take place in Animals. We see in the Nerves that there is a fluid or liquid which I suppose is continually filtrated thro' them & I imagine that there is a peculiar concretion between this & the other you have heard me speak of so much, and this may act as we know Electricity does in Plants.

As to any supposed Stimuli existing in the blood I entirely reject, because if there was Habit would obliterate or render them of no effect, I therefore reject this Oscillatory motion of Dr Whytt's as neither necessary nor probable. Having now considered all the Motions or powers that take place in the Arterial System,

Let us next consider what causes the return of the Blood thro' the Veins. This depends upon the same power as that of the former, but then the resistance here is so great that the blood is liable to stagnate in different parts of the System. The very rising of the blood contrary to it's gravity is a very considerable one.

Many hypotheses have been started to account for the Motion of the blood, most of which we shall pass over, but Dr Haller is a person of such repute that wherever he is in an Error we think ourselves under the necessity of pointing it out. §. 171

Verscheuir has spoke fully of this & proved that the Veins are irritable. This is universally allowed in the Sinus Venosi, & it is to be found in both ~~in~~ the Vena Cava, but as to the Contractibility of the extreme veins I doubt it much. — We cannot suppose the blood to be more fluid in the Veins than Arteries as Haller does, nay so far from this that I think it is just the contrary except in the Subclavian where the Lymph is poured into the venous Blood in it's rout towards the heart. There may indeed be a considerable absorption by the veins. We believe the red veins to be Absorbents, but then it cannot exceed the Exhalation from the Arteries except where there is an Absorption of humidity from the Atmosphere which may sometimes happen, yet we know that Absorption in general is performed by the Valvular Lymphatics which only communicate with the venous blood in the manner just now mentioned.

The regular return of the venous blood is only carried on regularly under a proper degree of Exercise, a principal power then by which the venous blood is carried onward should seem to be the Action of Muscles. As to Respiration since the neighbouring parts yield so much it can have little effect. The Action of the Muscles since they become leſs during contraction must both preſs the adjoining vessels & force this blood forward wch is prevented from flowing back again in the Veins (even tho' there should be a degree of Vacuum found in them) by the valves, & also squeeze the blood out of themselves. It may perhaps be said that this would likewise prevent the Arteries from carrying onward this blood. Indeed it might be the case if this Action was long & constant, otherwise not; and the valves must make the determination of this blood certainly towards the Heart.

Air is an Elastic Gravitating fluid which always preserves itself in Equilibrium, but it's particles repell one another from whence arises it's Elasticity, but being a gravitating body it will be densest at the bottom, hence we have a quantity of Air in a vessel it will be of the same Density & Elasticity as the common Atmosphere which is different in different degrees of heat - thus it must also be in the Lungs - Heat rarifies, Cold condenses it. I must suppose you acquainted with the Anatomical Structure of the Lungs. Tho' I speak of the Lungs as a hollow viscus yet they are divided into innumerable cells wch are all perviable to the Air, & there is a great deal of Nicety in the structure of them. They are covered externally with a proper Membrane besides the Pleura that is impervious to the Air.

There is only one paſsage the Trachea or Aspera Arteria by wch air can paſs into the cells of the Lungs, but then this is again divided into very minute branches that open into cells which communicate freely with one another.

Upon these Cells there are spread innumerable blood veſsels, called Pulmonary, wch ramify upon them into a prodigious Minuteneſs; these veſsels & Cells must yrfore suffer a peculiar compreſsion at some peculiar times or in Expiration — We shall now proceed to Explain

Respiration which is the alternate admiſsion into, and Expulsion of Air from the Lungs, and

1. The power by wch Respiration is performed.
2. The effect it has on the motion of the blood.
3. Why these Motions are alternate
4. The change the Air itself undergoes.

First. Powers of Respiration. We must consider the Lungs as bladders capable of being enlarged or diminished; thus, suppose we have 2 or 3 bladders confined in a large one we know the same effect is produced upon the Outer one whether we distend it by blowing Air into it or into the smaller ones contained in it, now we may consider the Thorax as a large bladder & the Cells of the Bronchia as the smaller ones.

The Diaphragm is naturally Convex towards the Cavity of the Thorax from it's attachment to the Mediastinum &c; and if we make a contraction of it's fibres it will be more brought into a Plane which enlarges the Vertical Axis of the Thorax wch can also be enlarged in it's Horizontal Axis as bounded by the Ribs and Sternum, if these are moved, being fixed behind, they must be pushed forward and outward or the Ribs from having an Angle before they arrived at the Sternum will be brought nearer together, and thus the capacity of the Thorax is enlarged.

The question of the Action of the Croſs fibres or 2 row of intercostal muscles is now well settled among the Anatomists, and it demonstrated that they both aſsist in the same Office of elevating or drawing the ribs closer together. These Muscles & the Diaphragm are the powers by wch the directions of the Thorax are enlarged. The Diaphragm is the power generally employed, but where it is insufficient the Intercostals are called in, as in Pregnant Women & Hydropic people, & even these are aſsisted by the Muscles that are attached by one extremity to the Thorax, the other to the Shoulder &c. &c.

The capacity of the Thorax can also be diminished, for as soon as ever the Stimulus stretching the parts above mentioned is taken off the Elastic power of the Cartilages and Membrane restore them to their former natural situation, & the ribs, diaphragm, & thorax will be restored to the situation they were in before Inspiration. The Action of the Abdominal muscles, the Sterno & Infra Costales may also aſsist in this by drawing the upper ribbs towards the lower, & in violent excretions the Sacro Lumbalis, Quadratus, Latiſsimus Dorsi are frequently called into action. The Elasticity of the Lungs themselves, both the cellular part, the branches of the Trachea, and the covering they receive from the Pleura makes them disposed to recover their former collapsed state, especially the muscular fibres of the Bronchiæ and this great Elasticity.

This alternate admiſsion & Expulsion of Air or Enlargements & Contraction of the Lungs & the effect it has upon the blood may be easily conceived from our Simile of Bladders.

There are Experiments to shew that the Respiration does not always stop nor the Lungs entirely collapse altho' the Air be admitted to the external surface of the Lungs by an Aperture into the Thorax; Nay they were even pushed out & distended thro' the whole to a considerable bulk & Mr Bremond found that Respiration did cease for 7 or 8 times after he had raised the Sternum & opened the Thorax. But in these Experiments we are to take notice that the Air wch gets into the Lungs is soon heated above the temperature of the external Air & consequently is rarified & it's Elasticity increased in a similar manner to a bladder not quite full of Air is distended by heating it, & this is sufficient to explain the above Phænomena. After an Animal has once breathed it's Lungs are never quite freed of Air, & but a small quantity is taken in or expelled in each Inspiration or Expiration.

We come now to consider what are the effects of Respiration upon the Blood, suppose the Lungs in a collapsed state. Now if the Air rushes in it dilates & fills the whole Air Vesicle & enlarges the Thorax & Membranes upon wch the blood veſsels are spread; this must therefore expede the blood thro' them, but if this still be pushed on & carried further it must compreſs not only from the Elasticity of the Air increasing but also from more pushing in to restore the Equilibrium wch will prevent the free

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transmiſsion of the Blood and an uneasineſs & sense of Anxiety will be produced which prompts us to expell the Air by Expiration.

Inspiration is a strained & violent state brought on by Action of Muscles, & from what we have said of Muscular fibres a relaxation must naturally succeed. When the Lungs are got once into a collapsed state the blood cannot move freely thro' them but is stopt in the Sinus Venosus Jugulas & Vena Cava descendens regurgitates in them brings ~~an~~ an anxiety which proves a Stimulus & hence the Muscles are again put into a state of Contraction, & thus Inspiration is again produced.

This I think is a simple & easy Solution of the Alternate Contraction & Relaxation of the Lungs & Organs of Respiration which depends upon the paſsage of the Blood being more or leſs free.

Besides this certain changes happen to the Air. -Air by being long breathed loses it's Elasticity, or if confined in the Lungs too long. But this is so little in one natural Respiration that it cannot be much affected. If the same Air once taken in was constantly to remain it would become unfit for the purposes of Respiration & even Poisonous to Animal life.

By an effect of the Animal Oeconomy not yet explained there is constantly arising from the Lungs of Breathing Animals certain vapours wch are destructive to Life, and the effect of Air is to mix with this & carry it out of the body, but if the paſsage be for sometime stopt the air at length becomes as if it were saturated with it and absorbs no more, Whence it's deleterious effects upon the System, and this also is the reason why Animals continue to breathe for a short time after the Larynx is stopt. The nature of this we know from similar Air produced in various manner, as if a portion of Air be confined for any time upon the surface of the Earth it becomes of this nature & Poisonous. The same also arising from effervescing & fermenting substances, it is very different from common pure elastic Air but in what is not yet determined; it is called fixed or more properly Mephitic Air.

This is entirely rendered mild & harmleſs by being mixed & diffused in the common Atmosphere, but whether this happens from Mixture or merely diffusion is not at present our busineſs to explain. In the busineſs of Respiration merely it is provided to procure a fresh supply of Air.

If Mephitic Air be allowed to remain in the System it produces Death by destroying the Mobility of the Nervous Ether. My ingenious Collegue Dr Black has greatly improved our knowledge with respect to this substance. This I suppose to be all neceſsary for understanding Respiration & its causes. We might here consider the changes it induces upon the blood by repeated exposition to heated & cool air &c but this will more properly come under the head of the Chemical mixt in the Animal Oeconomy. I shall first say some little on the effect of the Circulation of the blood. 1st If it is not the cause of the Generation of heat in the body it at least distributes it to every part.

2d It gives a due degree of Moisture to different parts of our System.

3d It gives also a Tension to the several solid fibres of our System & it must stretch constantly & occasionally every Muscular fibre.

There are likewise other effects, besides these, to be considered. The Blood when circulating in the larger Veſsels is an heterogeneous maſs, from which various secretions are made by a sort of Colature or straining thro' parts that are fitted to let one part of this Maſs paſs & not another. This is called Secretion & is one of the chief purposes of the System & to effect which the Veſsels must be divided into a series of still smaller & smaller veſsels.

We shall find that the preparation & application of Nutriment depends upon the state of Tension – Secretion & Nutrition still remain to be spoken more particularly of.

The Original Stamina are prodigiously small portion of matter in comparison of the whole adult Animal Machine. The effect then of the circulation must be capable of preparing matter fit for producing the Solids which are all made from the fluids. (This depends upon changing one mixt & forming another, but this belongs to the Chemical part of our Practice; to which we shall now proceed.

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Chemical System

This, like many other parts of our System is still on a very uncertain footing. What can be delivered with accuracy and precision I shall lay before you, & this I shall be able to complete in a small compaſs. —

In our consideration of the Doctrine of the Animal fluids I shall be guided by Chemical principles, from whence I demonstrate this part of our Institutions the Chemical System. The System has been treated in different ways by Physiologists. — Dr. Haller considers the Fluids as already formed in the system, and afterwards enters on the consideration of the constituent parts and the mode of their production. Boerhaave has followed the contrary plan, and begins with the Constituent parts of our fluids, the matters out of which our fluids are formed & the Animal matter from them, and the progreſs of the changes produced in their Conversion to the Animal fluids. The advantages of this latter method in clearneſs & simplicity are sufficient inducements for us to prosecute it.

It has been customary to introduce Morsus, Manducation, Deglutition and Digestion as preliminary, but this I shall not attempt accept some little matter on the action of the Alimentary Canal.

In studying the nature of the Animal fluids I consider them as formed of the Aliment taken in, & we shall endeavour to discover the gradual changes they undergo in their conversion in the Animal fluids.

I set out with a position that our fluids are formed from the Aliment taken in, from whence is derived the gradual accretion of bulk in Animals. Other subtile sources of increased bulk we shall wave the consideration of, as the Air &c, but these hardly deserve our attention, and we shall confine ourselves to Aliment as the matter from which our parts derive their increase.

In order then to consider the manner of Nourishment we ought to observe that the body is throwing out, very constantly, considerable quantities of matter nearly equal to what is taken in; therefore the whole of it's substance after sometime may be supposed to be formed entirely from the matters taken in. How then is this produced? The Aliment is vastly different from the matter produced. Most Animals feed on Vegetables — You will urge perhaps that there are some that live entirely upon other Animals; but here you should reflect that these Animals wch they devour were originally fed on Vegetables, and thus it is not difficult to trace the whole of Animal matter from a Vegetable Original; but here however a considerable change is brought about, we must enquire in what manner.

From the Moment it is taken into the mouth we may suppose it as undergoing some change; but the chief part is performed in the Stomach, for the other are only preparatory. The Operation of the Stomach may be reduced to three heads, *Solution*, *Diffusion* & *Aſsimilation*.

No change or solution can take place in solid matter, unleſs it be united with one in a fluid state, hence the neceſsity of Solution. We see that there are some matters which neither suffer a Solution or intimate mixture, here we suppose it only to be divided or blended with the fluids contained in the Stomach; this is *Diffusion*. There are also changes produced in the nature of the mixt, this we name from it's ultimate effects, *Aſsimilation*.

I. Solution is produced or performed by the same means in the Stomach as by every other Chemical Operation – the solid matter is first divided or

Manducation and then infused in a proper Menstruum that is capable of diſsolving it. The whole Maſs is likewise kept in constant Agitation & in a suitable degree of heat; these we shall consider separately.

1st The Menstruum. Many hypotheses have been started on this head, but it is now universally allowed that the chief is the fluids we take in, & this in most cases is pure Elementary water which makes 99 parts of 100 of the drink of the whole Animal creation, & the human species this is the basis of every drink. — Impregnations of water little alter it's solvent power, and we find in numerous instances that Solution can be perfectly performed, hence we conclude that Water and Water alone is the chief Menstruum of our food.

To this we may indeed add the Saliva & gastric liquor which transude from an Infinitude of Arteries that open into the Stomach & Intestines, & which is very considerable as we learn from the Exper^{ts} of Mr. Senac. There is also a great quantity of mucus different both in source & quality from the gastric liquor. There are likewise several other Animal liquors occasionally thrown into the stomach that were originally separated in the Intestines, but upon various occasions regurgitate & get into the Stomach. But we have no Chemical Exper.t that proves that any of these have a peculiar solvent power above water, therefore to supercede any further needleſs enquiry we shall have recourse to Water alone as a Menstruum or Solvent, aſsisted by the other powers of Division, Agitation, and a proper degree of Heat.

2.d In Animals the matter is chiefly broke down by Manducation wch is a pretty intimate division & a sufficient operation preparatory to the Action of the Stomach.

In the Schools of Physic, particularly in those of our own country, it was formerly imagined that the Stomach had a power of Trituration. This was taken from the Analogy of Birds in which I believe a proceſs of that nature occurs, for the gizzard is firm & solid in it's texture & seems to serve the office of Manducation by another Mechanical power _ Tritu=ration.

But we have no reason to suppose a similar operation takes place in Man the sides of whose Stomach never come into intimate contact, & is so tender an organ that it could never produce or bear any such operation. Nay we find that if any matter of great firmneſs be swallowed it paſses in it's entire state thro' the Intestines.

3.d But the Stomach may constantly agitate the Maſs & apply the Solvent to every part of the matter to be diſsolved. The effects of this are easily understood by every one who knows any thing of Chemistry, for our food is generally of leſs specific gravity than water, and hence the neceſsity of constant agitation to keep it mixed with the Maſs.

This Agitation is performed by various powers— 1. The peristaltic motion of the parts. 2. The motion of the Stomach in consequence of it's connection with the Deaphragm, this however is but of little importance, & even joined to the pulsation of the Arteries is so trifling that I reject it entirely.

4.th Heat. That of the human Stomach seldom exceeds 98 degs of Farenheit's Thermom.r, and this we find to have very little power in producing Solution in watery Menstrua, and this Physiologists have of late discovered, but have endeavoured to mislead us by a number of hard unmeaning terms, and would seem to insinuate that the Stomach can receive additional heat from the surrounding viscera & other parts aſ if these parts were not in the same temperature as the whole System, and upon the whole it is no more than this. If a substance that is colder than the Stomach be taken in it must deprive it of a part of it's heat, but this is soon restored to an Aquilibrium by the circumambient parts.

Besides what I have mentioned there is also another considerable mistake, that Stomach is frequently conceived to be as a closed digester. Haller says, Ore clauso, which is undoubtedly a great mistake, for it is by no means the case of the Stomach; from this cause it was supposed that heat generated in the Stomach was there confined, but this is absurd; for the natural degree of heat of the body seems to be the most proper for promoting Solution in the Stomach of Animal or Vegetable Substances, for a degree of heat above this, viz. 150, has the effect of coagulating them and renders them much more difficult of Dissolution. Hence the natural heat is the most proper for favouring the Diminution of the attraction of Cohesion of these matters & resolving them down.

It is to be doubted whether or not we are to allow Air taken into the Stomach to have any power here; it is taken in in large quantities & being colder than the Stomach it must be expanded & probably agitate the Contents. Hence I must conclude that this affair of Solution is a very simple matter & that there are no saline or other Acrid matters applied, nor have we proof of any Impregnatns being more effectual solvents than water alone. Most Physiologists have imagined these powers of Solution sufficient to answer every purpose of Aſsimilation. It does not indeed break down the fabric of Animal & Vegetable Substance, but this is merely confined to the soft & cellular parts, for the fibrous & firmer ones suffer little or no change here and any alteration in those is made by putrefaction taking place; this however is only to be taken in a groſs & limited sense

It affects Animal matters more powerfully than Vegetable — I have known a Man take a pound of Mustard Seed by six drams at a dose which all paſsed thro' the Intestinal Canal entire & unbruised, and so far from there being a power of Triture in the Stomach of the strongest Quadrupied, a grain of Oats will paſs thro' the whole Alimentary canal without change. In our species the husks of the most tender fruits paſs unaltered. The patient that took the Mustard seed retained it in his bowels for some weeks, & I have been lately told by a Physician of eminence in this city of a patient who voided Soap pills undiſsolved. From these facts it is plain that the powers of trituration subsist not in the human stomach, and those even of solution itself in some cases but weak.

Physiologists say that tho' we imitate the human stomach in Menstrua, heat & Agitation, yet we can never perform digestion or this kind of solution; this is certain & therefore we must have recourse to some other power. Such a one is fermentation whose power of breaking down Maſses is well known, by extracting the fixed Air and making it become Elastic. But by this I do not imagine fixed Air to be the Cement of bodies, as Haller, Hales, & Macbride do — Dr Hales first started this Theory, that the separation was the ultimate resolution of the particles of bodies; but this I am far from supporting, on the contrary I esteem the doctrine of Cement to be an absurd one, for Cohesion depends on the mutual affection of all the parts of a body — but fixed Air being one of the constituent or component parts the separation of it which is easily effected must produce a resolution, but yet not so complete as the advocates for the doctrine of Cementation imagine. Hence we mantain that the powers before mentioned aſsisted with Fermentation is all that is necessary for the Solution of our food. Our Aliment consists in a great measure of Water & Oil; both of which are found in greater or leſs quantities in all Animal & Vegetable Substances; how the last is managed is a more difficult problem. — Water alone is not a Solvent for it & in the Stomach it is not so much diſsolved or diffused, for it is found unaltered in the chyle and even Milk of Animals therefore this is not effected in the Stomach.

II. Diffusion. In Pharmacy we can mix oils & water by means of Mucilages & a proper degree of Agitation & we may suppose something of the same nature to take place in the Stomach. —

As to the saponaceous quality of our fluids I know nothing of it, besides I mantain a perfect soap does not in the least assist the combination of Oils & Water, neither do I know of any satisfactory Exper^{ts} that shew any peculiar power above that of Mucilage in our fluids, or even in the bile itſelf in uniting Oil with water, on the contrary there are some Exper^{ts} of D^{r} Ramsay in others that make much against this opinion.

III. Aſsimilation or the entire change of vegetable Matters into an Animal matter, or those of one Animal into that of another – this change is not completed in the Stomach, but the first step is brought about here, & indeed in some measure nearly takes place, but it is difficult to determine as to the thorough completion of this proceſs, whether further changes towards a more perfect Aſsimilation takes place in the Lacteals or not seems as yet beyond our Investigation.

We observe that a Fermentation does take place – The chemists who poſseſsed the first rank in Physiology introduced fermentation & their other proceſses into every part of nature, but with very little succeſs

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did they apply them to the Animal body. Upon this account the Mechanical Philosophers who succeeded them rejected these notions entirely, and said no fermentation happened unleſs in a diseased state. However in the Stomach I think there is evidently a ferment, because all our vegetable food is of a fermentable or Saccharine Nature which is the basis of fermentation, consequently it must happen in our Stomach. Besides we discharge considerable quantities of Mephitic Air which is evidently the product of fermentation; this upon separation is rarefied & increased in bulk, hence perhaps some may say it is only common Air, but we are convinced of it's having the properties of Mephitic or fixed Air.

Boerhaave seems to have been inclined to adopt this opinion, but on recollection that there were some things according to his notion absolutely incompatible with fermentation he was upon the whole very strenuous in rejecting it. He aſserts that the heat is too great, but this objection by no means excludes the poſsibility of it under particular circumstances. It is not indeed the proper degree

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concerning the Rysheian & Malpighian Systems of Glands — the latter supposed the glands a congeries of follicles — the former that they are composed of a decreasing series of vessels. It is compromised now that follicles are interposed between the secerning and secreting Organs in many cases. The Malpighian structure in some degree is then to be admitted, but there are many secretions & excretions performed without the intervention of follicles, these are composed of a series of decreasing vessels, the arteries divide very minutely & the secretory vessels pour out their fluids, or uniting again may rise in an encreased series & form excretories, this is the Ruyschean structure — Even upon the Malpighian doctrine we must in every case almost admit the Ruyschian system, for I know not an instance of a fluid poured into follicles without having undergone some change in a series of decreasing vessels — What effect these decreasing vessels have we are at a loss to say — the difference of Aperture is the first that occurs, this may have some effect in separating the parts of a heterogeneous aggregate, but how these should give a difference of Taste, Consistence and other properties we cannot conceive —

It is certain however that difference of Aperture has an effect, thus Secretions are different in the fœtus & the adult– To avoid this difficulty they have said the fluids here were the same, but this is contradicted by Experiment in the fœtus & adult. The Secretory Vessels are liable to spasmodic affections; it is well known that most of our Secretions are affected by disorders of the Nervous System which we cannot suppose to act any way but by contraction & relaxation. The Urine has ordinarily oily saline & earthy matters, giving it odour, taste & colour, if upon an affection of the Mind these properties should disappear we must suppose a Spasmodic affection of the kidneys– when groſs matters come out we cannot well say this is owing to an opposite state, viz, Atonia, or to increased impetus— encreased impetus however in many cases certainly alters secretion, & we cannot suppose it acts in any other manner than by varying the Aperture. In Anatomical Injections nothing is more common than for the fluid part to paſs into Veſsels wch do not admit coloured parts, tho' this may be done by increasing the force of the injection, here then is evidently a secretion depending on increased impetus and a different size of aperture. All these apply well to the hypothesis of the previous existence of the fluids in the mass, & nothing more was required on the supposition of all the Secretions formally existing there than a separation of these one from the other which office was done by the glands, ~~the~~ the strainers, or secerning Organs. But if we take the other supposition of a chemical alteration in the nature of the fluids & not merely a separation taking place of new products by the glandular apparatus being made from fluids perhaps entirely dissimilar in properties, if we take up this notion we must endeavour to find out a more applicable hypothesis. Mr Winslow supposes that at the first formation of Animals the Secretories are imbued with certain fluids that only admitted such as were like themselves, analogous to the circumstance of paper oiled which will not admitt water, & vice versa; this is specious _ but we may object that any secretion may be poured out by almost any other secretory or vessels, thus bile frequently passes by the Kidneys — again in an Ischuria renalis the Urine comes out at every outlet, but of this if requisite we could produce a variety of instances. Another hypothesis is that the fluids are moved by a capillary attraction & that the matter of a certain density has a natural affinity with fluids of the same density, hence the fluids would associate with the organs of their own density nearly, but there is no ~~more~~ such diversity in the density of our vessels & the passage of secreted fluids by other secretories than their own sufficiently excludes this hypothesis – As the doctrine of a decreasing series will not explain the effects of change of mixture that takes place, here must then be some power of mixture & fermentation that helps to form our fluids. Physiologists have supposed here that vessels secreting certain parts may again Anastomose & unite their parts in different proportion, but the existence of these is very doubtful & have never yet been ascertained by Anatomists. But if fermentation is necessary to Secretion this can never be supposed to take place in a decreasing series of vessels, & therefore they have so far adopted the system of Malpighi by saying that the secerning vessels poured out a fluid into certain follicles wch there underwent a fermentation in consequence of its stagnation. This opinion is founded on Anatomical Observation where by a Minute injection we observe the follicular structure, being little bags distinct from each other, having no vascular continuity, which the advocates for the Ruyschian hypothesis interpret to be a particular disposition of Vessels in the glands sometimes rolled up in various convolutions, at other times leſs tortuous like a brush, which causes the deception of the follicles, for when the vessels are unravelled (w^{ch} the minuteneſs of them renders impoſsible) they appear to be merely vascular; but upon the supposition of a stagnation in the follicles these powers may take place, viz,

1. Mixture.
2. Fermentation.
3. Absorption.

1. Mixture. Here what we mentioned may take place more perfectly, several fluids may be poured in different proportions & thereby give different properties.

2. Fermentation. This has been excluded, but it must be allowed in most cases to take place; the progreſs of the Chylopoesis shews them in the morbid states of the body; it has been said that this is formed by a particular

secretion & this perhaps is true. From Gaber's Experts we know pretty certainly that Pus is formed of the ordinary Serum & varies as the Serum varies in it's contents. The formation of the Pus depends evidently on a certain progress in fermentation; it further is perfected by Exhalation or Absorption.

3. Absorption. It may operate by abstracting the thinner parts; this may have two effects,

1. If the thinner fluid is Acrid it will leave the thicker more mild, this takes place in Mucus.

2. If the thicker is more Acrid the Absorption by taking off the thinner will leave the Secretion more Acrid, this takes place in the Bile.

We have now discussed the doctrine of Secretion as far as our knowledge of the Subject will admit of; this is one of the most important & at same time the least known of any function of the body. I ment.d a variety of opinions all of which have their Objections, even that of follicular stagnation & being subjected to a fermentative process meets with many difficulties, for there is no room for stagnation & consequently none for fermentation where the fluids are perpetually hurried on by such a rapid motion. There may be a secretion on the supposition of parts merely united by diffusion, for we have nothing in nature analogous to this different size of aperture in forming a new mixt; if we afsume the notion of Secretion being merely separation then this may have some effect, if not we must return to that very difficult problem how a decomposition is produced. Supposing the Mafs of blood to be an heterogeneous aggregate we may suppose by a different size of Apertures a separation may be performed & hence a new mixt produced. I shall illustrate the whole of this by an example altho' of a morbid secretion, it occurs however readily in our System — I allude to the production of Pus, this is a fluid not existing in it's proper form in the mafs of blood, it is the production of new fluids, we find it depends on a state of the series of decreasing vessels & is never produced but when they are under peculiar circumstances, when the vessels are in an inflamed state, here then we have a state of a series of vessels occuring in every part of our System, these separate from the blood a peculiar fluid, whether the fluid undergoes any peculiar change in passing thro' these vessels is uncertain, for the pus produced is in consequence of a subsequent fermentation wch changes the fluids in the common mafs.

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we before mentioned from Gaber's Exper^{ts} that Pus was produced from the ordinary serum of the blood w^{ch} in order to effect that change must undergo a fermentative proceſs, for it is not previously existing in the Maſs, only a change brought about upon the fluids of the Maſs that disposes them to a fermentation. This gives a more complicated view of the different parts of Secretion, I now add a particular with regard to the power of the secretory Organs, this power appears not only (from reasons given) to produce the ordinary change upon our fluids, but also in varying these considerably as we find several of them considerably diversified which must be owing to some peculiar circumstances in the present state of the Organ, as in Stimuli applied to excretory ducts & perhaps to the secretory vessels, produce considerable changes in the properties of the secretions. It has been thought that irritability was merely confined to the excretory tubes. In suction of a Child at the breast where the excretories are emptied we find the secretion increased in a greater proportion as the largeneſs of the evacuation requires; but from this there is a change in the quantity & quality of the fluid & this must proceed evidently from the secretion being too quickly urged on; this takes place in perhaps all our Secretions & is a proof of their irritability, i,e, of the Secretory tubes because any increased motion must imply the application of a Stimulus — other powers acting on the Nervous System can produce an alteration in the state of every secretion in the body; the instances of the paſsions of the Mind affecting the common Origin are sufficiently obvious, & some of these are more disposed to act on one secretion than another & producing gradual changes in the different fluids. Anger operates on the Secretion of Bile, & Fear operates on the Alimentary Canal. We know many other affections of the Mind have a considerable influence on the several secretions of the body, it must act on the excretory tubes in consequence of their having a Muscular coat & it's fibres being put into states of relaxation & contraction by their action produce a change on the condition of the fluids. We shall find this to be of considerable influence in our Pathology, as

Physicians have been hitherto too rash in inferring the state of the blood in the common maſs, from it's state in the Secretories for the secreted fluid independant of it's modification as a Secretion is liable to be influenced by the various causes above mentioned, whose effects are in a manner topical without any affection of the common maſs. There is no doubt but an affection of the common maſs may affect a change in the Secretion, but this is by no means universal, for they are merely owing to changes in the secretory organ itself; therefore tile we can thoroughly ascertain particulars we can by no means admit of general conclusions, thus in Gouty people when the chalky matter is thrown out on the joints I cannot affirm that this matter previously existed in the Maſs, the blood may remain as before & concretions may be generated by the state of the vessels. This finishes the distribution of the blood in Animals united into two general purposes, 1, and that we have been considering is Secretion; the other, still more important, is especially for the production of matter neceſsary to give growth and support to the body: This is what we call Nutrition which respect the supplying the fluids and solids.—

Nutrition.

Under this head I comprehend every part of the Animal Oeconomy relative to the support of the body. I previously observed that this might be considered as a branch of the former Subject of Secretion, but I referr it to a separate Article, with a view of treating it in a way more general & comprehensive. The subject naturally divides itself into two kinds—

I. The Support of the fluids.

II The Solid matter giving the substance & form to the whole.

The first evidently depends on the Aliment taken in & assimilated to our fluids & therefore relates to functions we have already considered. Hitherto we have touched chiefly on the preparation of fluids as to their qualities; there are some questions concerning the proportion of Ingesta

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& Excreta, and others which remain to be considered; that we shall hereafter insert in our Pathology. Our present object is

The Support of the Solids.

Our Solid matter is certainly derived from the fluids & hence this function (respecting it's immediate formation) depends much on the former. As yet we have considered the fluids as forming one common Maſs, and as performing the different Secretions. Our view at present is to consider what portions of the fluids are distinct for the supply of the Solid matter, the manner of it's separation & application to the Solids in their proper place, and further the means by which it is fitted from it's fluidity to assume a solid form, under the Arrangement we observe to take place in the Animal body. These questions will appear to admit of two divisions

I. The Extension or growth of Solid matter in every dimension.

The Animal body, originally of an imperceptible bulk, constantly encreases for a certain period till it arrives at a considerable size. To this rapid extension Nature has set her limits, & little further Accretion occurs but such as may contribute to give a greater density to the parts already formed.

II. How after the Complete formation of the parts, the Animal body is exposed to the alternate viciſsitudes of waste & repair.

From the time that Vitality is infused into the Germ, till the System has progreſsively arrived to it's complete dimensions, we are to consider the matter as applied to the increase of the bulk. Different from this may be the reparation of waste which only occurs when the size of the body is completed.

I shall begin with the first. The minuteneſs of Animals at their first formation, & the mode of application & provision of the new additional matters for the increment of the whole.

You will observe that this question is intimately connected with another relative to the formation of bodies, Animal as well as Vegetable, the prosecution of which must neceſsarily involve us in the busineſs of Generation, a question long agitated and hitherto remains an inexplicable mystery. I have ever been fond of questions that had the remotest tendency to Elucidate a subject in view, this however curious is of no Sensible Utility, being for the most part inapplicable in our System of Physic. From our want of insight into the Oeconomy of Nature these Subjects are necessarily involved in obscurity & confusion, such therefore we reject & avoid a clue that would lead us to such a labyrinth of uncertainty.

It is necessary for us to state the question more generally & shall deliver the two prevailing opinions concerning it.

I. That Organized bodies depend on certain Germs or Stamina first formed by the Creator; that these from a small bulk originally, receive all their subsequent increase, by Evolution, by the extension of parts already formed & deliniated, that merely in consequence of this further extension, do they aſsume their after complicated form.

II. That such Stamina are no where existent in nature, but there is a power in every Animal of producing such Stamina with other matters determining it to a certain form, and that all it's matter is first begun in a former Animal; On such a

supposition

* Traites du Corps Organizees.

supposition most part of it's complete Organization must have been begun and constructed in the Mother, that while the matter exists there are peculiar powers in the mother to modify the Germs or Embryo. Or for a shorter form of these questions,

Whether or not is every part of the Organization delineated in these Stamina, and that the after growth depends entirely on Evolution? Or in the Stamina only of so many parts as may determine the after organic Accretion or Epigenesis? I was disposed to assume the first supposition & adopt the Notion of Original Stamina, for this reason that the growth of Animal bodies so far as they come under our inspection evidently depend on parts already formed & deliniated, the extension & evolution of the parts being the sole means of all Subsequent Accretion. For a further view of this subject I referr you to M. Bonnet of Geneva*, and to Dr Haller in his Elementa Physiologia; the opinion of the latter is much to be regarded as formerly he set out on the other Supposition.

The Doctrines of Evolution & Epigenesis may both be admitted, which in some measure conciliates those different opinions; thus it is supposed that the Ultimate Ramifications of the Arteries are formed in the Stamina, which tho' not permeable to fluids in the state of Germs, yet are afterwards in the progreſs of vitality opened by impelling fluids in consequence of a more perfect Evolution. But there are other parts that are not vascular & which there is no reason for supposing preexistent in the Stamina or original germs. A matter, for instance, is pushed out, which forms the Nails, that is allowed to be an organic concretement & is merely the effect of Protrusion, but perhaps we may consider the skin & other parts as not preexistent in the Stamina, & then an Epigenesis so far happens with Evolution.

In whatever view we consider the subject it will be impoſsible for us to conceive the formation of the Animal body without the supposition of Original Stamina formed by a superior power. I shall confine myself to the following Questions.

I. What is the proper Nutritious fluid?

II. What portion of the fluids in the Animal body seem more especially to give the Nutritious fluid?

III. Whether this is a fluid every where present in the System of vessels, ready to be applied to the

Solids? or,

IV. Whether it is generally diffused in our fluids & requires to be separated from the heterogeneous Mass previous to it's application?

V. By what means when separation has taken place, is it conveyed every where to the ultimate fibres of the System of Solids?

VI. What are the circumstances of it's application, or how do these ultimate fibres become extended by the fluid, which must likewise be converted into Solid? — Or, a better form of question is

By what means, when thus conveyed, the fluid is converted into the Nature of the Solid fibre, as to encrease it's extension & solidity?

In a Subject so envelloped with difficulties as the present I cannot expect to demonstrate the several questions with any degree of certainty. In a path so intricate & obscure it will be sufficient if I arrive at some degree of probability.

As to the first question I have already alledged, the Nutritious fluid to be the Coagulable lymph, either in the condition we find it in the common Mass of blood, or as furnished by proper secretories, probably this is the chief substance produced from

Aliment taken in, it is the principal Animal fluid, and the intermediate state between Acid or Acescent Vegetables & putrid Animal Substances, & from it's being the object of Chylification & Sanguification it must certainly be destined for the support of the more permanent parts, the Solids. It bears a perfect resemblance to the Albumen ovi, the Nutriment of Oviparous Animals, & from whence they draw the Accretion of the Solid & fluid parts, the consumption of which fluid is proportional to the growth & increase of the Animal, whence from a similarity of properties we transferr the Analogy to their Mutual Utility, each from it's nature adapted to the purpose of Nutrition, & the Albumen being manifestly Nutrient, the conclusion from the sameneſs of property to the sameneſs of function, seems inevitable.

The chief difference that occurs with respect to these fluids, is, that in order to the application of the Coagulable lymph for the purposes of Nutrition a separation from Saline matters must take place as we don't know that in any Viviparous System we can find the coagulable lymph distinct and separate from the other parts of the Maſs, being constantly combined with a Saline fluid, the Serosity.

Objections have been made to the Similarity of the Albumen Ovi & Coagulable Lymph; that the former does not coagulate when exposed to the atmosphere; but every other Examination shews that they are even materially the same. This difference seems to be owing to some more intimate mixture of a diluent fluid between the particles of the Albumen, a fluid that from every trial appears to be a most perfectly mild water. We never have this pure in the coagulable lymph as it neceſsarily entangles a portion of the Acrid Serosity. The Albumen then probably undergoes some preparation which we must suppose is perfected by a Secretion. Such a proceſs is equally necessary for the fluid in Viviparous as in Oviparous Animals, the lymph being inadequate to the purposes of Nutrition till previously purified by a Secretion.—

If then Coagulable Lymph is the matter from which the Nutritious fluid is formed, a particular Organ must be appropriated for the office of Secretion. Contrary to this doctrine is the opinion of Boerhaave & his followers who aſsert that this change is performed in every part of the System, in every Arterial extremity.

Boerhaave supposed that every evanescent artery poured out a fluid for secretion, & from his notion of the construction of these, viz, their continuity with the Nervous Extremities, concluded the Nerves were the Organs of Nutrition. He supported the opinion of the Brain's being a secretory, & yet allotted this office to the Arteries, highly improbable, that a particular Organ should be aſsigned, yet the function be in common to the whole Arterial System.

The difference between the Alb: Ovi & coagulable Lymph we before mentioned was owing to the more perfect separation of the former from Saline matters, & it is rendered probable from the Acrid Serosity being present in the circulation that Nutrition is not carried on in the larger vessels.

Having proved from the Analogy of the Albumen

Ovi & Coagulable Lymph that the latter is the Nutritious fluid in Viviparous Animals, we proceed to enquire by what vessels this fluid is distributed & applied to the different parts of the Solids, whether it is conveyed & supplied by Arteries or Nerves. Dr Haller & some other eminent Physiologists have aſsumed the opinion in favour of the Arterial System, but I experience several difficulties attending it's admiſsion. It renders two suppositions neceſsary, either that the nutritious fluid is in the veſsels in which it flows, immediately applied to the sides of those, to increase their extension, in which case if it is applied to the simplest Vessels it is conceivable and conducive to the end, but if it is applied to parts of a more complicated structure, to the layers of fibres of the cellular texture, it is not only neceſsary to suppose that it is immediately applied to the innermost but that it must transude thro' the sides of the vessels to penetrate the external surrounding matter.

If we admit of the Boerhaavian structure that every Vessel is formed of a Membrane wch is composed of an intertexture of extremely minute

Vessels, i,e, the Vasa Vasorum; if this System I say be admitted their mode of Nutrition is more conceivable & less difficult of Application. — But more accurate Anatomists have exploded this notion of their structure, and if you admit the body to be mostly composed of cellular texture then on the Application of Nutriment to the larger Vessels there must be an exudation thro' their Substance for the fluid to be in contact with those parts exterior to enveloping Vessels.

This Supposition is indeed mantained by no body, but they are reduced to the other, that if the Nutritious fluid is conveyed by Arteries it must be distributed by the smaller Arteries (the minima Vascula) to every point of the System. They say that the increase of the body consists in the growth of the cellular texture, which owes it's formation to the effusion of fluids every where poured out by the Arteries, & concreting, but their fundamental Supposition is erronious, for it is the fibrous staminal part of the System that is first formed, from which the cellular texture derives it's formation; now the Arteries are formed from the cellular texture is not so obvious, we must have recourse to the Nutritious fluid suffused in every part of the cellular texture, it is present in every part of the blood, but being intimately mixed with the Serosity it must be prepared by the Secretories in order for it's application to the Solids. There is no proof of any such Secretion being made by the Arteries, and we know that the fluids they exude are by no means void of Serosity, the Lymph & halitus are in no condition to be applied to thee nutritious purposes, & hence the general Supposition that Nutrition is performed by a fluid distributed by the Arteries is in many respects unfavourable.

Another more probable Supposition & more applicable to the Phænomena is that the Nutritious matter is distributed & applied by the Nerves, & that these consequently are the Organs of Nutrition. To mantain this position it will be neceſsary to produce all the proofs in our power.

The first Argument I shall adduce is from Boerhaave, founded on the glandular apparatus being placed in the Cortical part of the Brain. It has been

long

* Vid. Boerhaave's Institutions. Parag. 440. 446.

long an opinion that the Nutritious fluid was supplied by the Nervous Canals, that the Brain was the Secretory Organ preparing the fluid for the Excretories, the Nerves. Tho' I am of opinion with *Boerhaave as to his general position, yet I must confess his Arguments in proof of it are by no means conclusive. The Quality of the blood determined to the brain has been much insisted on as of considerable Importance, but I think more might be urged from the quantity, so considerably superior to the fluids in any other Organ. This added to every appearance of a singular apparatus in the brain affords the strongest presumption of a secreted fluid; but these alone are insufficient for a proof, and had I not other Arguments for the distribution of a fluid along the Nerves to the Solids, the inferences from the quantity & structure would be inconclusive. Considering then the brain as a gland the Secretion can only be supposed to be an aqueous inelastic fluid, consequently can contribute to no other than the purpose of Nutrition, such a fluid being previously proved to be inadequate to the functions of Sense & motion. Dr Haller has aſsumed the supposition of a Secretion in the brain which he calls the Nervous fluid, he at the same time inferrs that it is employed in the functions of Sense & Motion, & hence that it cannot be employed for Nutrition.

I would allow that the Subtile fluid which is the Instrument of Sense & Motion is not that of Nutrition, but he affirms that the Vehicle of Sense & Motion is a fluid secreted in the Brain, a supposition that is inconsistant with the nature of that fluid, for I have shewn that it is a fluid incapable of local motion, inherent & elastic, & it is unconceivable that so subtile a matter could be drawn from our Maſs of fluids by any preparation whatever.

I now proceed to corroborate our opinion by further arguments.—

Boerhaave sets out with observing that Nutrition is performed in the smaller Veſsels in the ultimate fibres of the body from which all others are formed. We see nothing in the Animal solids but fibres in various degrees of Composition, or Cellular Membrane. Nutrition must be performed by Applications to these &

to the Staminal fibres which lay the foundation for all after Accretion; but here arises an Argument that the Nerves are the Staminal fibres of the body, & hence the basis of the formation of the rest whether by Evolution or Epigenesis.

We know that in the first appearance of the Animal Embryo the parts that are discernible are the Brain & Medulla Spinalis, & these are distinct & of a sensible bulk before any other parts of the System are visible; these are the Staminal parts, & every other part we may presume must be more fully formed and evolved by previous steps of Nutrition in these.

This is illustrated from the consideration of the Body being nearly made up of cellular texture, if any other matters occur in the composition, they have originally been so, but the cellular texture is so similar in it's several parts, & so little differs in the compactneſs of it's parts in any period of life that it has been generally esteemed an inorganic Maſs, & hence it is difficult to conceive that it should take on the particular size and form in an adult without some fundamental parts to determine the Arrangement and formation of the whole.

From every appearance the Cellular texture does not appear to have been a part primarily present in the Animal Embryo. The Cellular Membrane is often formed & repaired after the body is grown up, and therefore appears to be one of the parts of the after formation which arise from Accretion. These vicissitudes could never occur in the Staminal parts the fundamental constituent materials of the whole from which all others were extracted, arranged & delineated. The idea of a part fundamental to the whole being subject to destruction & reparation by parts formed from itself is inconsistent & contradictory, more especially as we adopt the doctrine of Evolution. It's quantity is confined to a certain degree which must be owing to a certain limited deliniation of it's parts in the Stamina. It's quality too in density, laxity, porosity, &c. varies in different parts; thus in the Sole of the foot this Membrane is of a much firmer texture than under the cutis in the Arm or other parts, & it could never have been so uniformly diversified except it's accretion had been influenced by the Staminal parts.

Haller & other Physiologists who are fond of deriving the formation of our Solids & fluids from the Cellular texture must unavoidably admit of two Suppositions respecting the fundamental parts of our System; whether they consist of simple fibres or of a set of Vessels deliniated in the Animal. If the Cellular texture is the primitive part, the basis of our System, it's structure must be either fibrous or vasculer; the Supposition that it may arise from Accretion on the surface of the veſsels proves nothing, for the question will recurr to the formation of the veſsels which depend on the Staminal fibres. The Arteries are composed of Fibres differently arranged, in veins & other membranous parts they are not discernible, tho' their composition it is probable is the same with the Arteries, & their structure is actually, tho' not visibly, fibrous. The negative Observations that a fibrous structure cannot be seen in the Dura mater pericardium &c cannot be admitted, for from Authors whose judgement is unbiassed we are aſsured of a fibrous appearance. The proofs that have been adduced to the contrary are entirely fallacious, & the negative Experiment of their resolution by a continued maceration into a cellular substance is unfair & inadmiſsible. For

Mr Vieuſsens has shewn that the Aorta itſelf is liable to a similar resolution, to which a fibrous structure can never be denied.

The existence of the Stamina fibres are not to be disputed tho' to us they are invisible, for in the progreſs of life they are covered & concealed by the accreted cellular texture; this is illustrated by the fibres of Bones wch gradually disappear in the advanced state of the Animal. Haller's Experts shew that the formation of the Bones is begun on a fibrous structure. In the long Bones the fibres are paralell & in the Cranium the fibres proceed rectilineally from a Nucleus as a centre every where to the circumference of the Bone. In the Interstices between the Arrangement of the fibres a matter is effused which hardens & totally obliterates the appearance of Fibres. This likewise most probably occurs in the Membranes & the Cellular texture, & hence the presumption is strong that the Animal body is formed of a fibrous which is the Staminal Structure.

If our Solids are made up of a composition of fibres they must originally proceed from the Nerves, as in the Embryo, we discover no parts to be under a fibrous Arrangement, but the Nerves & the Medullary substance of the brain & consequently all the fibres of the body must derive their formation from these. The Medullary Substance of the brain is under a greater diversity of circumstances than other parts, & tho' the exquisite delicacy of it's texture renders it imperceptible to our grosser optics, yet it's structure is more fibrous than any other part of the system. The continuation of this substance in the Nerves is certainly the same, both from the circumstance of the infinite subdivision it admits of & from the most evident & distinct fibres in the System being the Muscular. If these I have satisfactorily proved to be the continuations of the Nerves they will tend considerably to support our general doctrine of the fibres originally proceeding from the Nerves.

Another favourable circumstance in favours of our doctrine is, that the fibres in many parts of the System tho' originally derived from the Nerves, yet from various contingencies to which they are exposed, lose the peculiar properties of the Medullary fibre, & hence their Sensibility & Irritability. The Tendons in the opinion of Anatomists are continuations of the Muscular fibre, but from the state of the Cellular texture are exposed to various degrees of preſsure & from the Interstices being filled up with the solid matter to render them more compacted, it is not at all improbable that their original properties under such viciſsitudes should entirely disappear.

I believe with Dr. Haller that the Tendons are insensible & also with Albinus that they are continuations of the Muscular fibres, differing only in the fibres being more compacted & closely compreſsed. These together with the Membranes & Veins, originally Nervous become so changed in consequence of subsequent alterations as to be neither sensible nor irritable.

From this view that the Stamina of our bodies are of a fibrous structure, & these fibres are derived from the Nerves, a presumption arises that the Nervous system is the Staminal part of the Animal body, and that the delineated Organizations on which the other parts are formed, are previously existent in this System, & therefore Nutrition must be performed in the ultimate solids of the body & hence by the Nerves. The only objection to this is that Elegant doctrine of the Heart being formed in the original Stamina & that the growth of the body depends on the action of this organ, that the heart & it's system of vessels by degrees open & evolve the delineated organization of the various parts furnishing new matter for growth as it's Evolution gradually takes place; but from this consideration I derive an Argument that Nutrition is performed by the Nerves, as the heart antecedent to it's formation, must have it's irritable & contractile fibres produced, and if the Muscular fibres in general are formed from the Nerves the heart can be no exception, & it's substance must equally proceed from the same Origin. These portions of the heart are plainly it's fundamental part, & must have existed previous to the action of the heart. A Nervous System must have preceded these as eſsential to the formation & some degree of growth or Evolution must have occurred. The heart having it's Organization delineated in the Nervous System & increasing by power gradually evolving it from thence must manifestly be supposed to be consequent to the latter in it's formation, & must be merely in the first Rudiments of the Embryo in a state of vegetable existence till enlivened by the active power of the Nerves.

Dr Haller referrs to an ingenious Author, Mr Lionez who has applied himself to the consideration of the first beginnings of Animals, & it appears that in ir first formation they are but in a vegetating state & nourished in a manner similar to vegetables. Dr Haller indeed is of opinion that some animals are entirely nourished by a proceſs similar to the Veg. Nutrition, but for M. Lionez I cannot find in any part of his works that he is so positive on this subject as the referrence from Haller would incline us to imagine.

I shall add a further consideration – that the power we find principally employed in exciting Germs & contributing to their growth is the power of Heat wch operates by it's action on the Nervous System. I have formerly shewn that in Animals seemingly dead where the circulating fluids have coagulated, Heat will restore the Animal to life, & it operates by first exciting the action of the vessels before the fluids can be restored to their proper tenuity. This is an analogy that illustrates the first beginings of life & shews that the body is founded on a Nervous System excited to a state of Vitality by the operation of heat. But whatever is the conclusion this analogy may furnish us with, & however it may afford us a confirmation sufficient to influence our reasonings on the subject, yet a further illustration must be attempted, & if I can make it appear that other organized matters are dependant on a Nervous System our analogy will then admit of a conclusion.

The only Organized bodies we meet with in Nature (animals excepted) are Vegetables, wch are simply & entirely composed of one System of Organs, the Nerves. Every view we can take of a vegetable leads us to this Idea, as the whole of their structure consists of fibres variously arranged, & a Cellular Texture. The fibres & cellular Substance in Vegetables are arranged much in the same manner as in our Animal bodies. From the Medullary Substance of Animals fibres are disposed every where thro' out the System. In Veg.s in the same manner fibres are carried on but separate & uniform in size. It is now proved that plants absorb coloured fluids & the Absorption is carried on in single distinct fibres; if they separate it is only in consequence of a Fasciculus being separated but still into detached & distinct fibres. I use the term fibre without entering into the question whether they are hollow tubes or vessels having circulating fluids, or whether they are spongy fibres which filtrate a fluid along them as in a list of Cloth. To this we are little attentive, it is sufficient for us that these vessels are no where analagous to the Vascular System in Animals. They are not formed of large trunks ramifying to an imperceptible minuteness as in Arteries, on the contrary we find every where the appearance of fibres to be simple & uniform thro' the whole progress till you arrive at the utmost extremity of the plant. If in any part we observe an appearance of Vascular

=cular distribution, as in the leaf where the vessels of the Stalk appear ramified, we find them from more accurate inspection to be fasciculi of fibres analogous to our Nerves.

We have of late been able to inject the vessels of vegetables, & by the transfusion of a coloured fluid we have an opportunity of tracing the course of the Injection, & we find it to run in streight lines in so many distinct fibres, separate from one another without any appearance of Ramification. The particular collections of matter or fluids carryed on in these unramified fibres are poured into the cellular substance into the same parts where we find the oil in Animals. It appears then that veg.s are formed in a fibrous structure, & that such is their Staminal part first formed by the hand of the Creator. In the Bud or Germs of Plants we see the delineation of the leaves & fibres, these differ not in size, thro'out the process of vegitation, only here they are crumpled together, not being as yet extended by the Cellular Substance on the interposition of which their future bulk & formation depends. In case of leaves & fruits the same circumstances occur, the fruit is first formed by the Seed & a capsula surrounding it, & the after accretion is from the cellular texture interposed between the Capsula & outer bark. — Fruits are chiefly filled up upon the staminal parts by a pulpy cellular texture as you may see in Du Hamel's Anatomy of a Pear.

A more remarkable proof occurs in another part of vegetation, in the growth of woody trunks wch are formed by a succession of layers that accrete to the trunk from the Bark. From this annually layers are separated, which when first thrown out from the parts are gelatinous, but by the accretion of the cellular texture adhere more & more to the wood till they are formed into the the ligneous part. In order to ascertain this have recourse to the following Experiment, cut out a piece of Bark from the tree & upon the bare wood lay a piece of tin foil placing over it the separated Bark, in consequence of this an union will take place with the parts previously united, & in a number of years the tin will be covered over with the successive layers of wood so that it will appear to have been first place in the very centre of the tree. —

But

Our Application of the doctrine of Nutrition will depend much on the state of the case we set out with, & will considerably differ as we adopt Dr Boerhaave or Dr Haller's opinion. To the general position of the former I am inclined to aſsent, & have accordingly been employed in proving the Nerves to be the Organs of Nutrition. If a fluid is secreted in the Brain two functions only present themselves for wch this can be appropriated, these are the functions of Sense & Motion, and Nutrition. I have mentioned my objections as to the insufficiency of a secreted fluid for performing the more delicate offices of the former, for wch there is a fluid inherent in the Nerves of a Subtile Elastic Nature. The only function then for which this fluid can be aſsigned is for Nutrition & as Nutriment must be applied to the ultimate solids in which the original Stamina of our body consist, & the Nerves being the Staminal parts it follows that Nutrition must be conveyed & applied to the Nervous System, it being highly reasonable to suppose that the preexistent parts of the body are neceſsary to those that are afterwards to be evolved.

Anatomists agree that the solids were originally in either of the forms of fibre or cellular texture. The fibrous must certainly have been first formed or the Staminal part, because as we perceive it's increase in the further progress of the body it would be difficult to conceive the formation of such a complex organization from the cellular texture. It is probable then that the fibrous is the Staminal part that delineates the organization in the Embryo, hence the fibrous is the fundamental part & these are derived from the Nervous System being either Nerves as they exist or continuations of these in every part. There are fibres in every Membrane & vessel of the System, & all difficulties that occur as to their being Nervous are obviated by the consideration of their appearance being obliterated & the loss of their peculiar characteristics Irritability & Sensibility. The opinion, in opposition to this, of the vessels being the original Stamina & the fluids propelled by the motion of the heart produce the growth by the extension & evolution of the parts; this doctrine I say is superceded by the previous existence of the Nerves to the heart & from which the heart derives it's formation & the irritability of it's fibres, in consequence of which it's motions are produced.

Many parts are irritable in the adult that are not so in the Embryo state. Haller who condescends on particulars alleges that the Stomach is poſseſsed of Irritability sooner than the intestines, & this must be in consequence of a certain growth and more complete Evolution of the parts by the Nervous fibre. This applys to the heart whose fibres are produced from the Nervous System, the latter must have been previously formed in order to give the formation & peculiar qualities of Irritability so eſsential to it's function. There is one observation produced by Haller that the Animal is always first in a Vegitating state & this gives a strong confirmation that Heat is the power that excites the Animal Germs to life & is the cause of their subsequent increase. We have here demonstration that this power ~~here~~ acts chiefly on the Nervous System of Animals, and hence we may presume that the Nerves are the fundamental

=mental parts of the System from wch all others proceed & are supported, therefore the Nerves are the Organs of Nutrition.

From the consideration of Vegetables I said they were in structure analogous to the Nervous System of Animals, as their solid parts are evidently fibrous. These have the appearance of Cylindrical Substances, longitudinally extended; they proceed to the utmost extremity of the plant, of an uniform size, without any appearance of Ramification or Anastomoses— besides these there is a cellular texture constituting the chief bulk of the vegetable. Of these the fibrous part is the Staminal, the other is the additional accretion of cellular texture. This is illustrated by the ordinary growth of leaves & fruits, & by the formation of Wood from the bark of trees. If you examine a tree in Winter you will find the inside of the Bark to be smooth & polished in it's surface, destitute of Sap & not sensibly connected with the trunk or ligneous part; but in Spring the interior surface becomes succulent & turgid with Juice, more easily divisible into fibres, as is evident from the Veg. Cordage wch is made from the fibrous interior surface of the Bark. From the Bark a kind of Gelatinous matter is thrown out which acquires a firmer consistence & becomes a cellular texture, this gradually adheres to the outer layer of the wood, here it's bulk is augmented & it's cavities are receptacles for the Juices of the plant. This adhesion becomes gradually stronger, but is limited to a certain period. When the cellular texture becomes loose & detached from the cortical part till at last the connection of the bark to the ligneous part hardly appears. — Here then we have an appearance of a fundamental fibrous structure, a Juice is [illegible]cuded from the surface with such a determination to form a cellular texture, which afterwards acquires a firmer consistence & forms the ligneous part of trees.

Our general doctrine of Vegetables is now sufficiently confirmed, that the fibres are the Staminal parts which delineate the different Organizations that arise in other parts. The Vegetable Structure consists of fibres or of vessels analogous to fibres,

but

* Mr Gamper has clearly demonstrated that vegs
have no vascular System.

but without vascular Ramification or Anastomoses from such fibres vegetables are formed;* and this structure directs the after growth of the plant by the Cellular substance being joined upon it.

The Analogy between Animals & Vegetables being so far pursued & the sameneſs of Structure in each so clearly demonstrated we may venture to aſsert that their mode of Nutrition is analogous particularly as vegetables are formed & supported by a structure exactly corresponding to the Nervous System of Animals.

I have thus far defined the question whether the fibres of Animals & vegetables are hollow tubes or Spungy fibres, the latter seems much the most probable as we have no evidence from Exper^{t} of any uniform cavity in the former. Neither could any particular advantage be derived from the fluids being confined in hollow canals, for the velocity with w^{ch} fluids are carried on in so minute canals as the fibres of vegetables or the Nerves of Animals can never be attained by a force merely propulsive.

If they are tubes they are of such exility as not to allow the admiſsion of fluids by any impulsive motion, we must therefore enquire what other power is adequate to the transmiſsion of the fluids. An analogy presents itself that it is a power similar to the attraction of adhesion in Capillary tubes corresponding to the conveyance of fluids along spungy substances, & this may be the mode of propulsion in the fibres of vegetables & Nerves of Animals. But numerous Objections occur to the Doctrine of Capillary Attraction, & in every point of view it is unsatisfactory & inapplicable; other powers peculiar in their nature may be the means of conveying the fluids thro' the fibres, & hence may be adduced the Vis Nervea, adherent to the substance of the Nerves, the Instrument of Sense & motion.

To this there is a power Analogous in the case of Plants, & here we can not only transfer our reasonings from the Vegetable to the Nervous System, but also from the Nervous System to the vegetable. That Plants have a fluid of such Subtility plainly appears from their irritability and contractility; they are poſseſsed of these properties in a considerable degree & have peculiar contractile motions whose operations must be referred to a Muscular System. This is evident in the Sensitive plants wch are affected by the slightest Stimuli, & whose number are daily encreasing by the further discovery of Botanists; hence the analogy is easily transferred to the Animal kingdom & there is the greatest probability for supposing that the properties of each entirely depend on an inherent Elastic fluid.

Many Physiologists have referred Sensibility to plants, but this they have mistaken for Irritability which may exist separately & independent of the former. Many Experts have been lately made on plants wch inferr a peculiar irritability & a capacity of being acted upon by various powers. The action of Light has considerable effects on the Œconomy of Vegetables, and we observe from the Application of the Electrical fluid that the sap in plants is considerably promoted, & from the quickneſs of growth that occurs in Vegetables from Electricity it is probable that the Æther in the Nerves being affected it operates by conveying the Juices of plants with more velocity & forwarding their extension. From the whole then our Analogy amounts to this that in plants there is a Nervous System on wch their whole formation & nutrition depends. In Animals a similar structure occurs & the sameness of function must be inferred from the sameness of property in both & hence Animal nutrition is performed by the Nerves.

It is performed in consequence of every fibre of the System being continued from the Nerves, that these are the only organized parts, & whatever further accretion takes place is derived from the cellular texture. Here we might proceed to examine in what manner the growth of the plant is performed & determined, but we must be cautious of indulging a curiosity that may be more amusing than instructive; we are deficient in materials to go upon & must limit our enquiries till further Expert^ts^ are made.

As to the growth of Veg.^s^ we are apt to conceive that the root takes in the Juices & distributes them to the other parts of the plant, that hence the growth should

(c) in wch the heat is kept at the vegetating temperature, if we take in a branch within the Green house ——

should begin at the root & proceed gradually upwards; but we can excite vegitation in a particular part of the plant when none is going on in any other part.

A perenial deciduous plant will shew no tendency to sprout from the root in winter, but if it is brought into a green house of a proper temperature it may be brought to perfection. Botanical physiologists have attempted an explanation of this by saying that the heat puts the sap in motion & that the organization carries on the rest of the vegitation. It may however be excited at the top of the plant when there is no appearance of communication between that & the Root below. If we take a vine & set it in a pot of Earth & place the pot on the outside of a green house[a] that part shall alone be vegitating when the parts exposed to the Atmosphere shall be not at all affected.

This Exper^t may be greatly diversified by bringing a portion of the middle of the twig into the house while the top thro' a cavity is exposed to the Air. In this case the middle part only vegetates while the top & lower part are in the usual state of Torpor. — If again we place the root within the house & expose the branch that was before interior into the situation of the other parts, then the root & intermediate parts shall only vegetate & the part that before flourished will be now unaffected.

From these Experts it is evident that when the vegetation is carried on in the middle of the plant it cannot be supposed that the sap was confined to the vegetating part, but that it paſsed thro' the lower part of the trunk, & yet no Vegetation from it's presence took place.

These facts are extremely curious & interesting & shew us that not only the presence of Juice & Sap is neceſsary to vegetation but also the power of heat is eſsential by disposing the sap to act in a particular manner, in a way that is difficult to explain.

That there is a peculiar operation of powers is evident from this Expert, but how they operate I can by no means pretend to determine. Different however from this is Animal Accretion tho' in many particulars resembling, for in peculiar Animals there may be a means of exciting the heat to a proper degree where the part is growing, & hence a proper temperature is neceſsary for the particular Accretion in each. Besides the presence of Juice & the Staminal parts there is a portion of heat neceſsary wch operates only on the part to which it is applied. Animal bodies do not proceed thro' their whole growth in this Vegetable manner, for the fibres of the Animal or not extended by the impulse of the fluids from the heart. The Germ is at first actuated by heat & till the heart with the blood & vascular System is formed the animal is merely in a State of Vegetation, but after this we evidently observe that Evolution happens according to the extent of the heart's action &c The circumstances neceſsary in the Animal System are that the fibres are extended by the force of the heart, & a Vascular System is united with every fibrous part till the heart has acquired a power of action, & till the fluids are confined within their proper Veſsels the body is nearly in a Vegitating state; but as soon as the blood is propelled by the heart Evolution takes place in every part of the System & nutrition is carried on in the same proportion that the strength of the heart is exerted. The Evolution depends on the original Stamina and the bulk is earlier increased in those parts where the vessels are made originally in a larger proportion & are more fit & ready to be evolved. The vessels of the head, the Jugular veins & Carotid Arteries are the first that appear in the System, the blood is chiefly directed to the head & it's parts first take on their growth. The impetus of the blood at the same time that it is determined to the head is directed to the Umbilical Veſsels, & this distribution is neceſsary in order to form the proper connection between the Mother & the fœtus. In this way we can trace the gradual Evolution of Animals & according as circumstances occur that render the veſsels more lax & patulent, so in proportion to these will the fluids propelled by the heart be directed. Whilst the original Stamina direct the first impetus the extension will give occasion to growth & extension

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& solidity will be given to the parts that are formed. The first growth produces the first resistence & this encreases the action of the heart in proportion to the resistance of the vessels, & the Stamina will direct the growth & determination to others till the balance is exactly sustained. In this way we can conceive the parts of Animal bodies to be formed in succeſsion, the resistence encreasing in proportion to the extension & evolution in each. We see in a child just born where there is no farther occasion for the Umbilical chord the determination to this is suspended & the vessels composing it are stopped up while the fluids are directed to the extremities which previous to this were small in proportion to the rest of the System.

From this we may account for the ceſsation of growth in animals when the parts have acquired such a rigidity as to balance the action of the heart; the most obvious instances of this occur in Bones wch determine the growth of adult Animals. Very early in the Embryo we can discover the first rudements or stamina of bones, these are at first of a tender gelatinous texture; from this state they gradually acquire firmneſs till they proceed to that of a soft inelastic Membrane & afterwards acquire an Elasticity till they become hard & rigid & poſseſs of very little flexibility; this is the proceſs of every Oſsification, first the parts are colourleſs & transparent having no appearance of yellow or red veſsels, the Bone acquires little consistence till the yellow veſsels appear, when it is in it's flexible state, as soon as the Oſsification begins the red veſsels appear in the centre of the Oſseous matter, this is peculiar to the broad bones for in the others the vascular appearance is not strictly confined to their centre, as in the long bones. In the former the veſsels from the beginning Oſsifications are extended in streight lines to the circumference. In the latter they are extended rectilineally towards the extremities when they terminate in Epiphyſis.

Our first conclusion from these curious facts is the general confirmation of the Idea we have given of Evolution, that it depends on the extension of parts & hence a certain force of circulation is neceſsary to the formation of Bones. As to the mode of it's operation I can say little that is satisfactory, perhaps some power may prevail analogous to heat in the Vegetable System, by which the Nervous fibre is put into a condition to form a cellular substance on the surface, & it is not only neceſsary that this should be formed on the Staminal fibre, for the bones consist not wholly of a cellular texture that acquires hardneſs but of a Membrane in the cavities of which a matter is poured that hardens into Bone.

This Matter is universally allowed to be of the same nature with the gelatinous substance that forms the rest of our Animal Solids, but firmer in composition, & from this it would appear that a previous formation of veſsels must take place in order to give the Secretion to be poured into the Cellular texture.

Du Hamel has traced the formation of Bone thro' the several states, he has examined the matter effused into Cells & from his Experim^{ts} there is little doubt but that the formation of Bones & Cartilages are in this way accompanied. D^{r} Haller only attends to the particular secretion that is proper to harden into Bones, whilst he neglects the previous formation of the cellular texture intended as a receptacle for the osseous matter in every part of the System. There are Staminal fibres continued from the Nerves which by an impetus of the blood are put in a condition to exude a fluid which concretes into a cellular texture, by this the vessels are dilated, & a Juice is secreted that is varied according to the nature of the already formed cellular texture. There may be some difficulties attending this doctrine, but the substance of what I have delivered is to be received as a fact, both from the Analogy of Vegetables as well as from what we know of the formation of Callus & the generation of new flesh in wounds & Ulcers.

The whole of our Doctrine on the subject of Nutrition amounts to this that the Stamina of Animal Bodies, are probably their natural basis & the fundamental parts of our Solids &

fluids. The Nervous System is the Staminal part of the whole & the Nutritious matter must be conveyed by these because the increase of the System must be accomplished by the actension & evolution of these medullary fibres that are continuations of the Nerves.

In these alone the Organization is determined & delineated, the subsequent accretion being entirely derived from the cellular texture. This is illustrated by the consideration of vegetables that as in these Heat is the active power, so in Animals that or some power analogous to it puts the Nervous fibre in a condition to give growth to the cellular texture & to delineate the arrangement according to the quality of these Stamina. In Animals, it is the motion of the fluids propelled that dilate & extend the parts. The Arterial System is diſtended by the power of the heart, & this contributes much to the Evolution of the parts. I gave a particular Illustration of this in the formation of Bones, where there is no considerable progreſs, no true Oſsification without an

Extension of red vessels, & the growth of the Bone is always in proportion to the extension of these vessels. This may lead us to a supposition that the action of the heart gives growth to the cellular texture, but Bones are not composed of this Membrane but of a matter deposited in it's cavities for the secretion of wch a suitable Apparatus is provided.

I proceed to give an illustration of this in the formation of Callus, the occasional repair of broken bones, or of any loss of substance in these. On this subject I must observe that many controversies have occurred among Physiologists relative to the formation of bones, respecting the nature of the Membranes that by the receipt of the hardening matter become Osseous — and what are the Membranes that are to be the Stamina of Bones, & how these are distinct from the Pereosteum, or whether the Stamina of bones are to be considered as a Membrane of which the Pereosteum is a part, or for a shorter form of this question, Whether the Stamina of Bones are distinct from the Periosteum & separately from

* The former of these is the Opinion of Dr Haller & Bonet. v. Elem. Phys. Lib. XXIX. Sect. IV. The latter of Mr Duhamel.

the Bones, or whether the Periosteum like the Inner Bark of trees forms succeſsive lamellæ of Bones? *

Without determining this question the general fact appears to be that the Oſsification proceeds by the Succeſsive layers becoming Oſseous – one unavoidable cause of this lamellated structure is that Bones long before they acquire their full growth come to a limit of extension of the internal membrane. The internal Layers then being not yet entirely extended must be detached to carry on the succeeding Oſsifications. What I shall deliver concerning the formation of Callus will illustrate the formation of Bones; on this subject many disputes have been agitated wch we shall not minutely discuſs. One Argument I shall insist upon, that Callus is not an organic Concrement effused & fitted to harden, but it is an organized part of a lamellated structure with a copious distribution of veſsels even more vascular than the Bones, nor does the Oſsification of Callus ever take place without an appearance of veſsels.

We shall now consider the appearance of

Callus & it's progreſs according to Du hamel & Fongereaux, from the consideration of the progreſs of which & the distributions of the vessels you will be convinced that they are not derived according to Dr Haller from the Gluten of Bones, but from the Inner layer of the Periosteum — When a Bone is fractured an Oſseous Juice is effused by the veſsels between the Extremities of the Bone which grows hard & forms a Callus, this is Dr Haller's hypothesis, but a demonstration against it is that Callus is organized & lamellated as in natural bones; no Callus can be formed without red veſsels penetrating & proceeding as in the original formation of Bone, and it must be formed either from the internal or external Periosteum, & most probably from the last. My opinion therefore coincides with Du Hamel's that it is formed of the inflamed layers of the Periosteum, & a portion of the Bony matter is exuded from the inflamed surface, where it is deposited in Cells and there Oſsifies. In a fracture he finds that the Periosteum thickens & inflames & at last gives off a Lamella, the thickening is made of the cel-

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cellular substance into which a fluid is poured that concretes into Bone — now in a Bone that has arrived at its full growth, in consequence of a Fracture the sensible parts are affected & Inflammation from the affection of these is excited wch again induces the growing state — this is analogous to the reparation of a loſs of substance in other parts of our solids. Haller finds that in the Suppuration of tendons the Inflammation always begins in the cellular texture wch grows more & more compact, & hence the increased density so observable in the part.

It will be obvious from the formation of Callus by the separation of succeſsive layers that by this we should acquire an Idea of the Evolution of the other parts by the propulsive force of the Arterial System; in all other cases of renewal of substance the reparation is performed by the cellular texture — there is no new growth occurring without the formation of Pus & this neceſsarily implies an Inflammatory state; this gives a particular illustration of the formation of the cellular texture, the propulsive force of the Arteries increased by Inflammn determines the nerves to give new growth to the cellular texture, this is evident from the great Sensibility of growing flesh (from which we have a presumption of the influence of the Nerves in Nutrition) for the Impetus of the blood in Inflamm^{n} being greater than the resistance of our fibres gives extension & likewise that condition to the Nerves wch is necessary for their effusing the cellular texture. In the renovation of a part there is certainly a return of Sensibility & Insensibility in several parts where they have been disputed, thus the Nervous Staminal fibres may be so surrounded by the cellular membrane as to be incapable of the motion necessary for the purposes of Sense, yet when morbid & inflamed they may be restored to their proper Nervous State.

Some Arguments have been employed in favour of the Nerves, as the Organs of Nutrition; that when the Nerves are obstructed the parts are deprived of Nourishment & immediately shrink. D^{r} Haller mentions the Atrophy of Paralytic limbs, & this he first adduces as an Argument in favour of our Opinion & afterwards refutes it, but I would by no means employ this as an Argument, for the bulk of parts depend little on the solids but on the quantity of fluids and it is not proved that the solids are in this case diminished — the bulk of the fluids depend on the free progreſs of the circulation & when the Action of the Veſsels is diminished the parts shrink; the Paralysis affecting the vessels may prevent the tranſmiſsion of the fluids & hence the Plumpneſs of the Cellular substance & other parts may disappear, yet the solids be not at all diminished. Dr Haller objected to this & affirmed that it's admiſsion was incompatible, for he says the slow viscid fluid required for Nutrition could not paſs thro' the minute Nervous fibrils & is inconsistent with the mobile fluid required for Sense & Motion; but this does not appear to be true, for the fluid may be of the greatest exility & yet be in a condition for depositing the solid matter. The Albumen Ovi appears viscid chiefly from the cellular texture with which it is entangled, but in paſsing thro' the Minute veſsels of the Chick it is probably made extremely fluid & yet is in a condition to form solid matter — No one can raise doubts as to the matter forming the shell or outter covering of a Snail, but must admit that it is circulated in the slender veſsels of that Animal; the fluid in its system of veſsels may be dilute & extremely fluid wch by certain drying powers concrete. The Shell of an Egg is of the same kind & originally in the same state, the fluid is transmitted thro Veſsels of the greatest exility from the Mother, & yet paſses not in such a condition but that it is afterwards liable to concrete & form a calcareous shell.

The other part of his Argument, that the fluid of Sense & Motion the proper Nervous Æther is too subtile for the purposes of Nutrition, we may readily admit, for the fluids employed in each of these purposes are of a very different nature. Haller affirms that there are parts of the Animal body that are destitute of Nerves wch are yet nourished; but he will be unable to prove that either these parts have not or never were poſseſst of Nerves & till this is rendered satisfactory his Arguments cannot be admitted.

In Atrophy he observes that Sense oft remains whereby the Nervous fluid does not appear to be interrupted; here I would alledge that Sense may often remain in the Skin wch is an Organ of exquisite delicacy & has a remarkable proportion of Nerves, hence while it remains sensible in some degree the motion of Muscles may be lost. I observed that Paralytic affections do not produce a dimenution of the part in consequence of the nutritious matter being withdrawn, for the bulk of the solids is very inconsiderable to that of the fluids, which depend on the action of the heart; on this depends the growth and gradual evolution of the System, and this extension is continually going on till the resistence of the fibres is too strong for the action of the Heart. As the parts encrease in size, so likewise do they encrease in density, for if the Heart's force increased in proportion to the bulk of the System, growth might always continue, but we know that this proportion is continually diminished, till a just Equilibrium is formed. The muscular fibres acquire more density, tone, and contractility, and with these Oſsification has a great share; for by this proceſs many veſsels are entirely destroyed, and others rendered so rigid as to overbalance the action of the heart, besides the increased rigidity of the veſsels, the cellular texture is condensed by the increase of it's solid matter, and by preſsure tends to obliterate the veſsels it surrounds. Thus then as parts are extended, so their force to resist the extending powers must be constantly increasing, and either the propelling powers must be increased in the same proportion, or the effects be diminished till the resisting powers are in a balance with the propelling, and then all further augmentation must cease.

Besides the power of extension in increasing resistence, several others concur, as no preſsure &c; and though it may be difficult to apply to every particular phenomenon of Nutrition, yet the general idea of the Heart giving Extension must be allowed by all, and this joined to the doctrine of the original Stamina, explains the evolution of Bodies. We are certain then that the propelling power resides in the heart and larger veſsels; we find the heart to be among the parts of the System that first arrives at it's full growth; it is also one of the first that stops, and does not increase in proportion to the rest of the System; the growth is always leſs as you proceed towards the Acme. The heart, which in the Foetus was $\frac{1}{20}$ of the bulk of the body, in an adult has a much greater disproportion. Independent of the question as to the diminution of the Contractile power, the quantity of blood that is thrown out with respect to the Arterial System that contains it, is smaller and smaller, and here we understand how the Animal body encreases more in given times from its first being evolved, and the after growth is a series of proportionals continually decreasing. The Evolution does not take place uniformly in different parts of the System, for some parts arrive at their Acme sooner than others. This is explained by supposing that some veſsels in the original Stamina are more lax and patulent than others; this however is rather inferred from effects than actually proved. The superior organs should on many accounts first arrive at their determined Bulk, and accordingly we observe that the veſsels from the heart to the head are larger and have a freer circulation than those in any other part, the head then and it's parts are first formed and first arrive at their Acme. The lower extremities and those parts leſs forward in evolution are continually gaining upon the head. This will aſsist us in the explication of several Phænomena in Pathology. From the first beginning of Animals, and during the progreſs of their growth, the Arterial System is in a state of Hæmorrhage, and the increased action of the heart will appear more considerable in proportion to the particular determination, hence if any disturbance is given to the circulation, the effects appear more especially in the head, and Hæmorrhages of the Nose are more frequent in children, and before the age of Puberty than afterwards where congestions most commonly occur in the abdominal Viscera.

At the Acme when the propelling powers are in balance with the resisting, the preceding growth of the body must depend on the increase of the quantity. If the bulk of the fluids increase, while dilatation does not take place in proportion, then the Plethoric state will occur and shew it's effects in those parts where a smaller capacity is observable, as in the Lungs. This is a separate part of the circulating System which must preserve a certain balance with the other parts, the quantity of blood paſsing thro' the Lungs is equal to that paſsing thro' the Aorta in a given time, consequently, the transmiſsion must be made with greater velocity, and hence any change in the velocity of the blood will be more evident and apparent in the Lungs. This will more especially appear if the capacity of the Thorax is not enlarged in proportion, and hence a Plethora will have a greater effect upon the Lungs. From our doctrine we can easily understand how parts may be evolved according to the different proportion of the Stamina. The Genital organs are in both sexes fitted to be evolved at a certain period of life; about the time when the Plethoric state is most observable, the original stamina determine their Evolution at this period, and in consequence of this various irregularities are produced in other parts of the System. In the female sex where the Evolution is considerable, by the formation of a number of veſsels, in these the determination to the Uterus as connected with the Sanguiferous System will have considerable effects at the time they are evolved; this portion of the System is so ordered that it should have a considerable influence in forming a balance between the Nervous and Sanguiferous Systems, hence we shall understand why so many disorders attend certain conditions of the Evolution in the Genitals. With regard to both Sexes this is to be taken notice of, that at a certain period there is an Evolution of a part of the Nervous System, to be endued with new powers, Sensations &c, and with such circumstances as give it a particular connection the whole of the Nervous System – such considerations we are led to from the general Evolution of Germs.

The Evolution I am speaking of more especially consists in the dilatation & extension of the Arterial System, which from the Muscular fibres it contains is subjected to the influence of the Nervous System.

Another balance occurs between the Arteries and Veins; for the purposes of growth we observed that a Plethoric state of the Arteries was neceſsary; the Arterial System cannot discharge so much into the Venous, in the time of a Systole, as it received from the Ventricle of the Heart, and hence an Accumulation must ensue, which must depend on a set of veſsels not easily admitting red blood, or on a resistance of the Vessels immediately receiving it, if the Arteries terminated into vessels which admitted their contents with greater Eaſe, whether from laxity or size, the accumulation would be little or none, and therefore the extension and growth of the System would not be carried on; hence nature has provided a resistence to the Arteries by the Veins, which give a greater resistence to the Arteries in proportion as the animal is nearer it's origin, and decreases till it comes to it's Acme. Dr. Wintringham has measured the capacity of the Veins, and finds the latter to be thicker than their corresponding Arteries — if this fact is received that they are a provision of nature for the extension of the Arterial System, for as long as the Veins resist the Arteries, so in proportion are the latter more extended and fitted, and by this continual extension their density is encreased. At the period when all farther stop is put to the increase of the System the balance becomes equal, and from hence it must be evident that this encreased resistence must have an influence in determining the Acme; but from the very circumstances of distension and impulſe in the Arteries there is a tendency to increase their density and resistence, while no such causes are applied to the Veins, hence at a certain period an Æquilibrium must neceſsarily take place — hence the observation that Arterial hæmorrhages are more frequent to young people; in a more advanced life a Venous Plethora takes place, and if in these Hæmorrhages occur I would not assert them to be Arterial, but that they rather happen in the extremities of these vessels from the resistence in the Veins; corresponding to this we observe that the diseases of Youth are Hæmorrhagic and Inflammatory, those of old people; on the contrary, chiefly arise from Venous Congestion, to speak in the language of Physicians.

The reception of the Blood at the Acme in the various Secretories and Excretories, not before fully evolved, contribute to balance the increased impetus of the Arteries, instead of that resistence it formerly met with in the veins; perhaps the blood in the whole System is increasing in order to promote this further evolution. Here then we perceive another balance between the Arterial and the Excretory System, but in what proportion this is mantained in different periods of life we are certainly ignorant. We must conclude from effects, and say that between these and the excretories certain proportions are established that so much does not pass off as is taken in by Aliment, and hence more fluids are accumulated than the necessities of the System require. When the Arteries suffer no increase of capacity, and yet their contents are augmented, Nature has provided that the encreased quantity should be thrown out by the excretories; when this does not take place the bulk of the fluids is too great for the extension of their capacities, and a Plethora is generated. It appears to be a neceſsity of the System that as soon as the balance between the Arteries and Veins is established, a balance should take place in the Excretories that by these the Superfluous ingesta should be thrown out. It is thrown out of the Sanguiferous System, in consequence of a secretion in other parts, and tho' not out of the body, yet the superfluities are every where accumulated in the cellular texture, and are excluded by a proportional excretion when those balances are completely established, which, in Men, occurs about the 30th or 40th year, and then the period of Obesity commences. In this however there is a variety, but in general this is nearly the time. What circumstances of the System determine this condition is out of our power to say.

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